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B-52 STRATOFORTRESS

SCOTT LOWTHER

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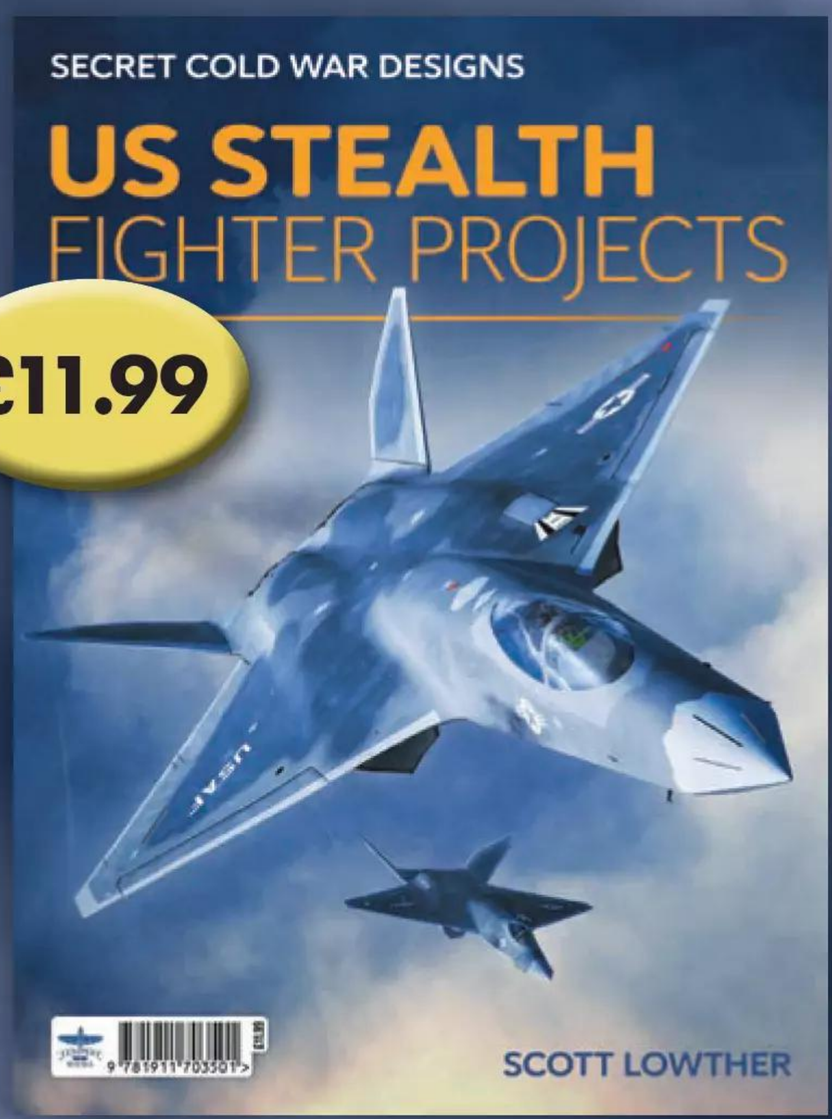

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Introduction

As hardly needs repeating, the Boeing B-52 Stratofortress is an icon of American air and military power. Developed just after the Second World War, it has been in service for more than 60 years – and there is every reason to believe that some of them may still be lumbering through the skies a full century after the breed first flew. This could be because the design is so supremely magnificent that it cannot be readily replaced… or because the American military procurement system is so mired in bureaucracy and expense that keeping aged aircraft flying well past their retirement date has simply proven cheaper than getting something new. There is validity to both views.

In its earliest incarnations, the B-52 was envisioned as something straight-winged and dragged through the air with propellers. That B-52 would doubtless have had a far shorter lifespan than the plane that was actually produced.

The development of the B-52 went on for a number of years however, years in which aeronautical knowledge was advancing rapidly. What was learned on Boeing's earlier B-47 was transferred to the B-52. And newer learning still was added, leading to the design that Boeing eventually sent skyward.

A handful of the steps taken by the company's designers to produce the B-52 have appeared in various publications over the years, but the actual evolution of the aircraft, even before the initial prototypes were made, was a process involving dozens, even hundreds, of design changes small, large, and utterly total.

This publication attempts to flesh out those evolutionary charts a little further, though it is by no means complete. As well as the evolution from first concepts to prototype, the various major variants that were built are included, as are a number of unbuilt projects for derivative designs. Some truly remarkable derivatives proposed have been proposed for the B-52, including nuclear propulsion, liquid hydrogen fuel and even supersonic variants.

Many more designs for research and operational aircraft were put forward to use the B-52 as a carrier aircraft, and a number of them are included here. The designs have all been recreated here as line drawings, useful for model builders. A source grade is included for each diagram in the data tables at the back to indicate the clarity or otherwise of the vintage diagrams these new images were based upon. Many of were based on diagrams found in the Boeing Historical Archives; others in reports, papers and seemingly random blueprints found in a multitude of widely scattered sources.

Scott Lowther
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1 CHAPTER Predecessors and Evolution of the B-52

It is a common misconception that the Atlantic and Pacific oceans provided North America with a natural defence against foreign aggression. Given that the founders of the United States arose from the flames of the French and Indian War of 1754 to 1763, the Continental forces fought British forces on American ground in the Revolutionary War of 1775 to 1783 and again in the War of 1812, it's clear that the United States has never been truly isolated from the effects of distant wars and foreign powers.

Still, up to the dawn of the Second World War many in the US could believe that distance would not only insulate the US from a European war but that distance would be invincible in both directions. Advances in aeronautics had ended that sense of isolation by the early 1940s, but this change in outlook did not come about overnight.

Boeing B-29

Perhaps the first truly modern bomber, certainly the most advanced long-range bomber of the Second World War, was the Boeing B-29. It was all-metal with a pressurized crew compartment and some of the first functional computers, used to help aim the remotely controlled machine gun turrets. And at the peak of its prowess it brought the war to a close by introducing the enemy and their environs to astonishing levels of artificial sunshine. The B-29 was not just another bomber… it ushered in an entirely new age.

That was not exactly the original plan Boeing's designers had in mind for the B-29. Starting out as Model 334A in 1939, then Model 341 in early 1940, it was intended to be an improvement on the state of the art to be sure. Model 341 was refined with improvements in defensive armament and other features to become Model 345 then resubmitted to the Army in May 1940. The Army's 'Superbomber' requirement called for a range of 5,333 miles with a bomb load of 2,000lb, which Model 345 seemed capable of meeting. So in late August 1940, the Army contracted for two prototype XB-29s. Two hundred and fifty B-29s were ordered in May 1941, raised to 500 in January 1942. This was unprecedented as the XB-29s had not yet flown and would not do so until September 1942.

The B-29 was able to meet its requirements by maximizing aerodynamic efficiency. The cockpit, typically raised on pretty much any aircraft up to this point, was fully submerged within the cylindrical fuselage. Defensive gun turrets were unmanned so they could be as flat and aerodynamic as possible, requiring advances in remote control technology. Construction was largely conventional, with a mainly metal structure and fabric-covered control surfaces; the landing gear, unusually for a large aircraft, was a tricycle arrangement.

The story of the B-29 has been often and sufficiently told. But for an aircraft aimed squarely at the heart of Nazi Germany, it is interesting that it was not used in that theatre; only a few were sent to Europe, and then only for propaganda and diversion. Instead, the many B-29s made during the war spent their time turning Japanese targets into rubble and ash. But here they were able to do so only because the United States Navy and Marine Corps had taken islands away from the Japanese, providing runways close enough to the Japanese homeland for the B-29 to carry out its mission.

The B-29 did have the range to reach targets in Europe from bases in North America. What it didn't have was the range to make it back to the United States. The distance from New York City to Berlin is about 3,950 miles; from St John's in Newfoundland, it's about 2,850 miles. Unfortunately the B-29A's basic mission had a radius of 1,843 miles while carrying 10,000lb of bombs. The only way B-29s could strike into Germany if Britain had fallen would be if the US operated from bases in Iceland. And if the Royal Navy was out of commission, US naval support for an Iceland base would have been forced to run an ever-present gauntlet of German U-boats. Additionally, the UK had invaded Iceland in May 1940 to forestall a German invasion; the fall of Britain would have likely ceded Iceland to Germany.

With all this in mind, in April 1941 the United States Army Air Corps issued a request for proposals for a long-range bomber capable to taking the war to Europe from American bases. Requirements were a range of 12,000 miles, a cruise speed of 275mph (with a 450mph top speed), a service ceiling of 45,000ft and a bomb load of 10,000lb. Over a shorter distance, an increased bomb load of 72,000lb was to be carried. Boeing and Consolidated began to work on designs to meet that RFP, but it proved beyond the technology of the day. The RFP was modified to make the aircraft somewhat less demanding in August

1941: range was reduced to 10,000 nautical miles, cruise speed dropped to 240mph and ceiling reduced to 40,000ft.

Even with the less exorbitant specification, Boeing struggled to produce practical designs that could meet them. Northrop and Consolidated felt up to the challenge and designed aircraft they felt could meet the requirements, being granted contracts to design and build the B-35 and B-36, respectively. Boeing didn't get a contract but did produce a series of studies – though the available information on these is not overwhelmingly detailed. This indicates that Boeing's work on these designs was not as thorough as the work done by their more successful competitors. Still, these early designs started Boeing down the road to designing true intercontinental strategic bombers.

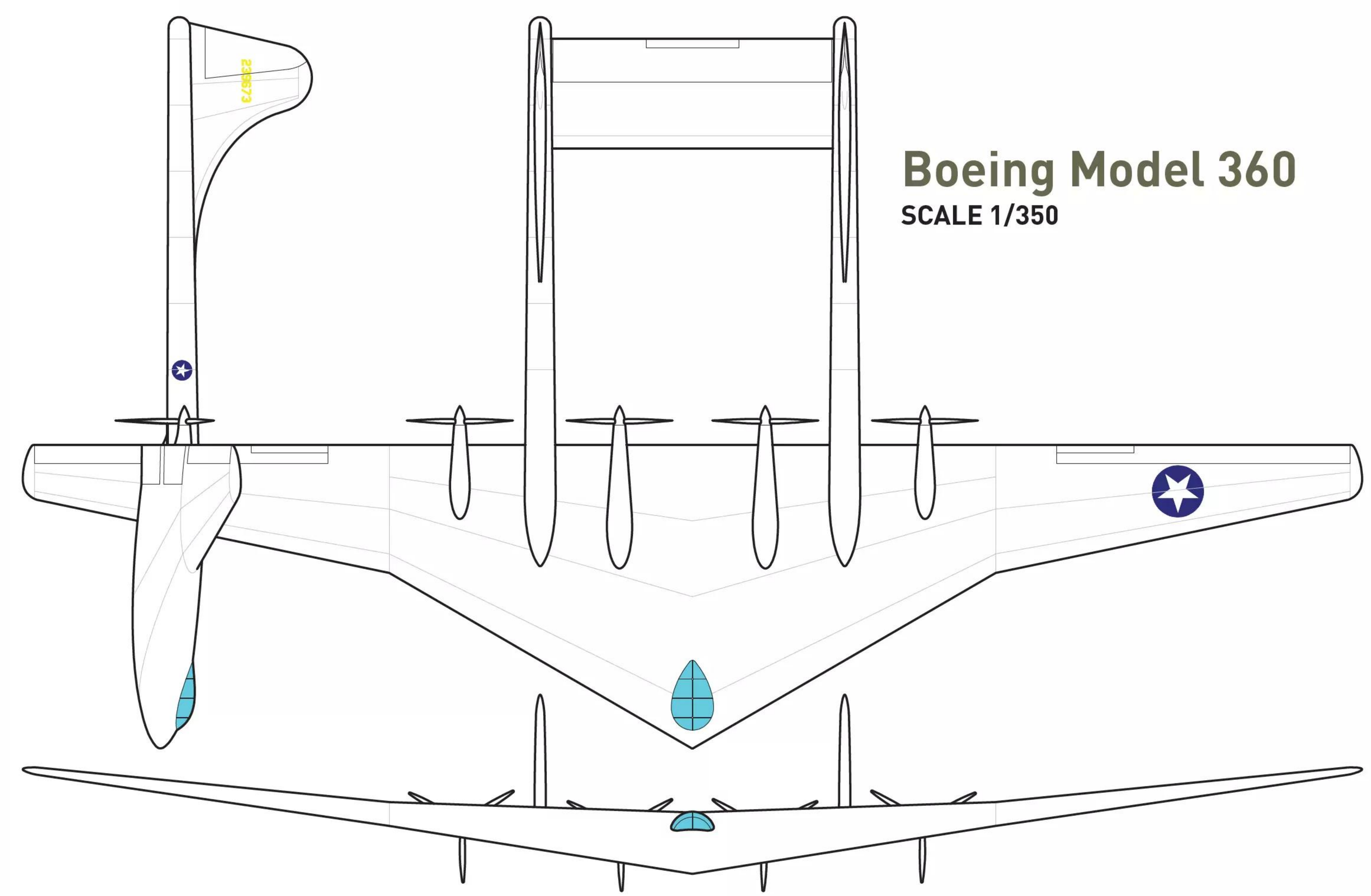
Boeing Model 360

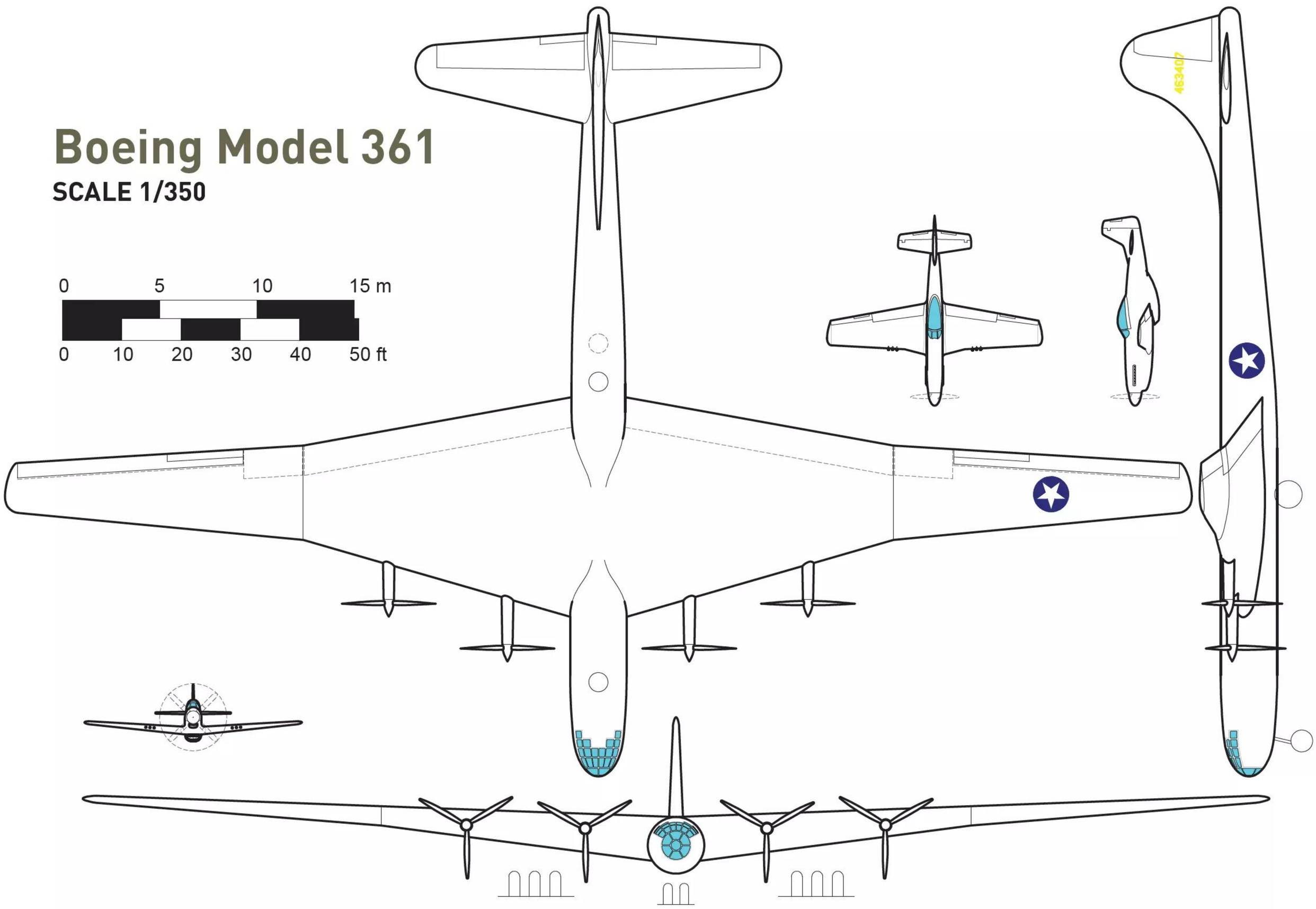
The Boeing Model 360 was an August 1941 design for a long-range bomber with a maximum payload of 40,000lb. It was an unusual configuration, which at the time would have been called a 'flying wing'. Configured much like the Northrop X-216H 'Flying Wing' from 1929, it featured a long span wing with a thickened centre section and no distinct separate fuselage.

A sizable rectangular horizontal stabilizer and two vertical stabilizers, each similar to that of the B-29, were held well to the rear by two relatively slim booms. Engines buried within the wing centre section drove four three-bladed pusher props. The only crew position depicted is a single sizable cockpit canopy; in all probability though, the airframe would have been festooned with gun positions. Certainly tailguns at the end of each of the booms, and likely turrets both above and below the central wing section. Unfortunately, little else is known beyond some basic dimensions.

Boeing Model 361

Like Model 360, Model 361 is known to this author from a single diagram. It appears to have married the B-29's fuselage and tail to an entirely new wing. The B-29's relatively thin high aspect ratio is gone, replaced with a very thick centre section housing the engines internally to drive tractor propellers via extension shafts. This, presumably, would have allowed in-flight access to the





engines for servicing and repair. The wing would also have provided considerable volume for fuel tanks and possible ordnance. The diagram shows the locations of three turrets, two on the upper side of the fuselage and one on the underside, but does not show the turrets themselves. It's not clear if this indicates retractable turrets or if the turrets are simply not depicted. As with Model 360, maximum payload is 40,000lb.

Boeing Model 362

Model 362 from September 1941 mixes the 360 and 361 configurations, with a conventional B-29-like fuselage and tail section with the blended wing/forward fuselage of the 360. The cockpit has a B-29-like greenhouse canopy, though modified somewhat to account for the sizable wing roots at the 'cheeks'. But the biggest change from the prior designs is the actual size of the vehicle… with a span of 300ft, this would have been one of the largest aircraft ever built, with a span exceeded only by the Hughes H-4 'Hercules' and the Stratolaunch 'Roc'. To provide power, eight undefined piston engines were buried within the wings, driving four contra-rotating pusher props.

This resulted in an aircraft that at last met the USAAC's requirements for performance, though at the cost of an immensely large and heavy aircraft. It does not appear that this design was submitted to the USAAC however; it may be that it was simply designed to see just how large an aircraft would have to be to meet the performance requirements based on the aerodynamic, structural and powerplant state of the arts.

Model 362 was to be equipped with a number of turrets. The available diagram shows the locations of five… one on the upper surface of the mid-fuselage, one each atop the wings at about mid-span and one below each wing slightly outboard of the upper turrets. It is possible that there was a lower-fuselage turret or a tail gun, but these are not indicated in the diagram.

The total defensive armament consisted of eight .50 calibre machine guns with 1000 rounds each and six

37mm cannon with 300 rounds each. Offensive payload was baselined at 10,000lb, but exchanging fuel for bombs could give a maximum bomb load of 20 x 4,000lb bombs, 28 x 2,000lb bombs, 76 x 1,000lb bombs, or an impressive 176 x 500lb bombs. The landing gear was of tricycle arrangement, but the main landing gear appears to be very far forward, likely indicating that the central tubular fuselage would not be used to house fuel or bombs, but was merely a structure to hold the tail surfaces well aft.

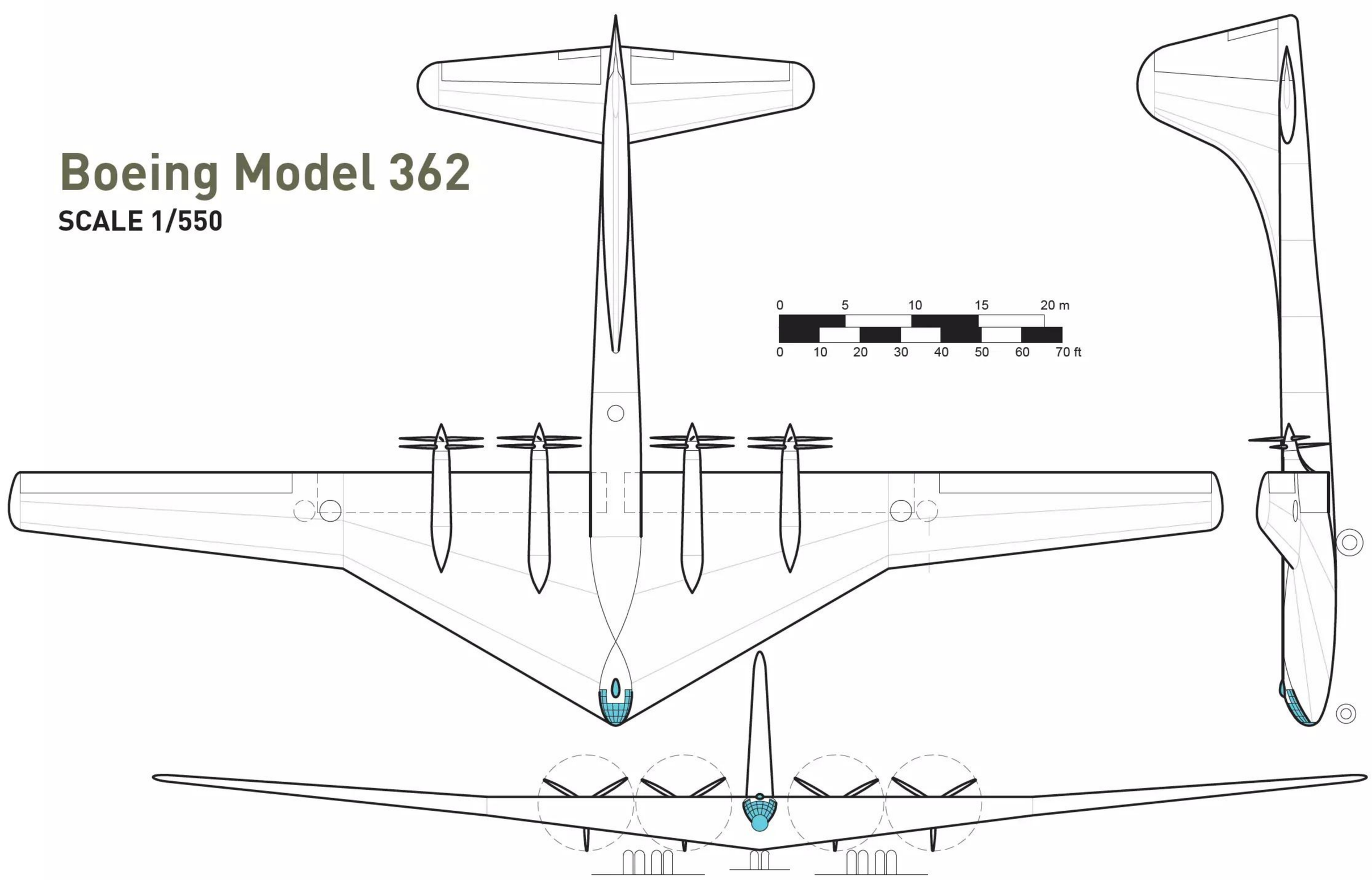
Boeing Model 365

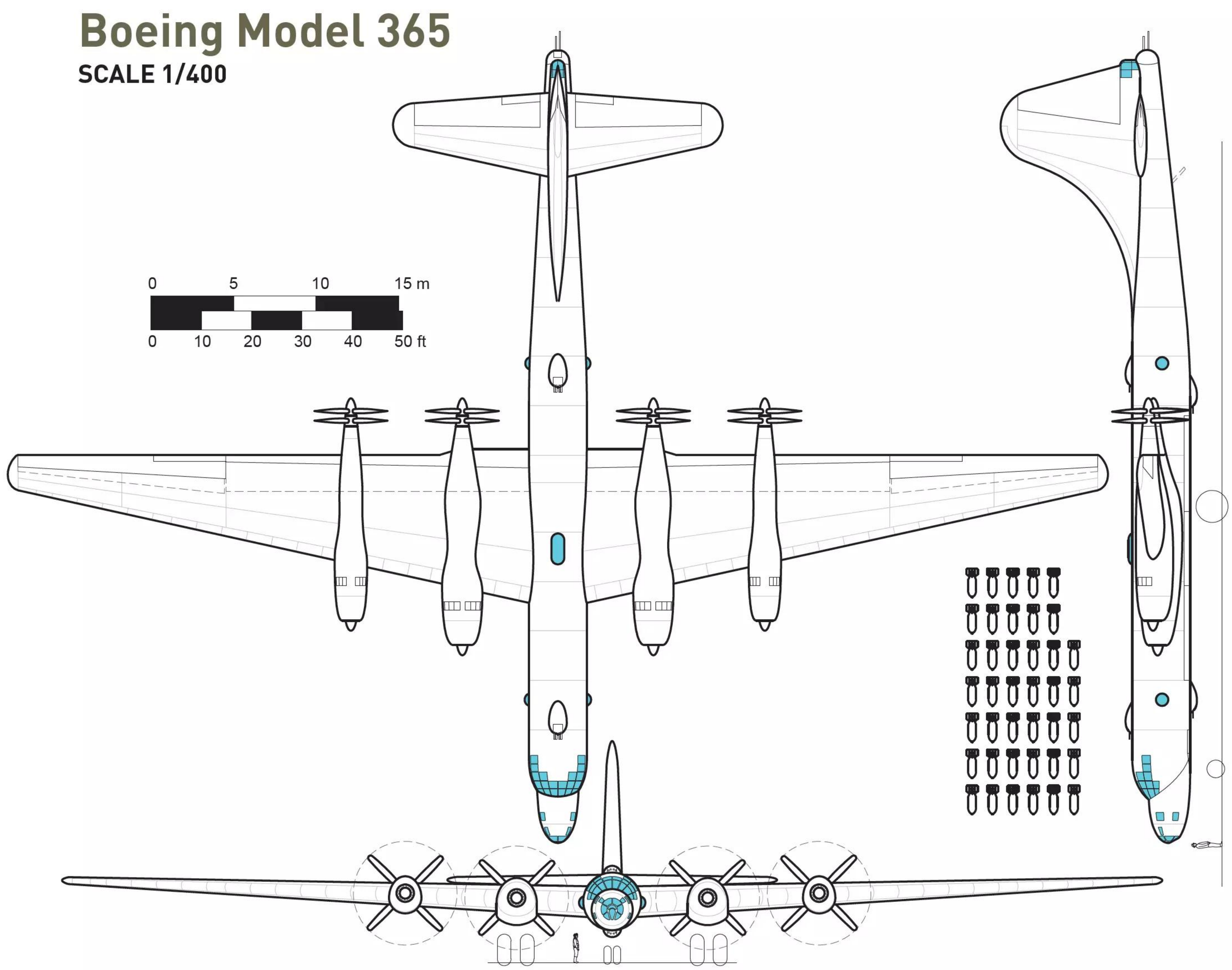
Boeing's Model 365 from April 1942 was in many ways a scaled-up B-29. The fuselage maximum diameter was increased 2ft from the B-29's 9ft 6in to 11ft 6in. Span and length were increased by more than 50%. And while the configuration was very much like the B-29, it featured some unique alterations. The forward fuselage – otherwise looking very much like the B-29's 'greenhouse' – was fitted with a proboscis-like extension, presumably for the bombardier. This extension looks like a scaled *down* version of the B-29 forward fuselage. The Model 365 had, like the B-29, four piston engine driven propellers, but the four Pratt & Whitney 'X Wasp' engines drove eight-bladed counter-rotating pusher propellers. The engines themselves were still located ahead of the wing leading edge, but the fairings and drive shafts extended well aft over the wing spars.

Defensive armament of the Model 365 would have been formidable, with four turrets, two on the upper side of the fuselage, two on the lower, all with four .50 calibre machine guns and a tail turret with two .50 machine guns and an additional two 37mm cannon. Each of the machine guns would have 800 rounds while the cannon would only have 38 rounds each. Maximum payload was to be 32 x 1,600lb bombs, though design payload was 10,000lb. Other bomb loads included two 10,000lb bombs, eight 4,000lb bombs, 24 x 2,000lb bombs, 40 x 1000lb bombs or 84 x 500lb bombs. Range is not given in the available documentation. The design does seem to fall about midway between the B-29 and B-36 in capability.

Boeing Model 384

Model 384 from October 1942 was another 'scaled up' B-29, with an increased length, span and fuselage diameter (to 12ft 3in). The 'greenhouse' canopy was replaced with a more conventional raised cockpit and canopy. The diagram depicts the aircraft with five fuselage turrets (two dorsal turrets, two ventral and one tail), all of





which are fundamentally different from the others. The raised cockpit and numerous sizable turrets represents a step backwards in the effort to maximize aerodynamic efficiency.

The aircraft has two separate bomb bays in the fuselage, with a 10ft separation between them. But the biggest difference in configuration between Model 384 and the B-29 is the landing gear: the former is something of a throwback, using taildragger gear rather than nose landing gear. This would lead to the Model 384 sitting with a distinct nose-up stance while on the ground, akin to the British Avro Lancaster.

The nose of the fuselage was a pressurized capsule, with the forward bomb bay directly behind. This would have made installing nose gear difficult. The relatively forward position of the wings meant that the main landing gear would be too close to or even ahead of the centre of gravity of the loaded aircraft. Put together, these issues made a tailwheel a virtual necessity.

Armament was 10 x .50cal machine guns with 800 rounds each and four 20mm cannon with 400 rounds each. It appears that the forward dorsal and ventral turrets each had two .50 machine guns, the aft ventral turret had four .50 machine guns, the aft dorsal turret had two 20mm cannon and the tail had two .50 machine guns plus two 20mm cannon. The offensive load was to be one 10,000lb bomb, two 4,000lb bombs, five 2,000lb bombs, ten 1,000lb bombs or 20 x 500lb bombs. Range was well short of the 10,000 mile requirement.

Boeing Model 385

This August 1942 design had a conventional configuration with six engines. Once again it appears to have taken the B-29 as inspiration, but with everything stretched. The available diagram is fairly rudimentary (and contradictory between top, side and front views), indicating that the design was not well advanced. Payload was nominally 10,000lb, but it could carry a maximum load of 32 x

Boeing Model 384

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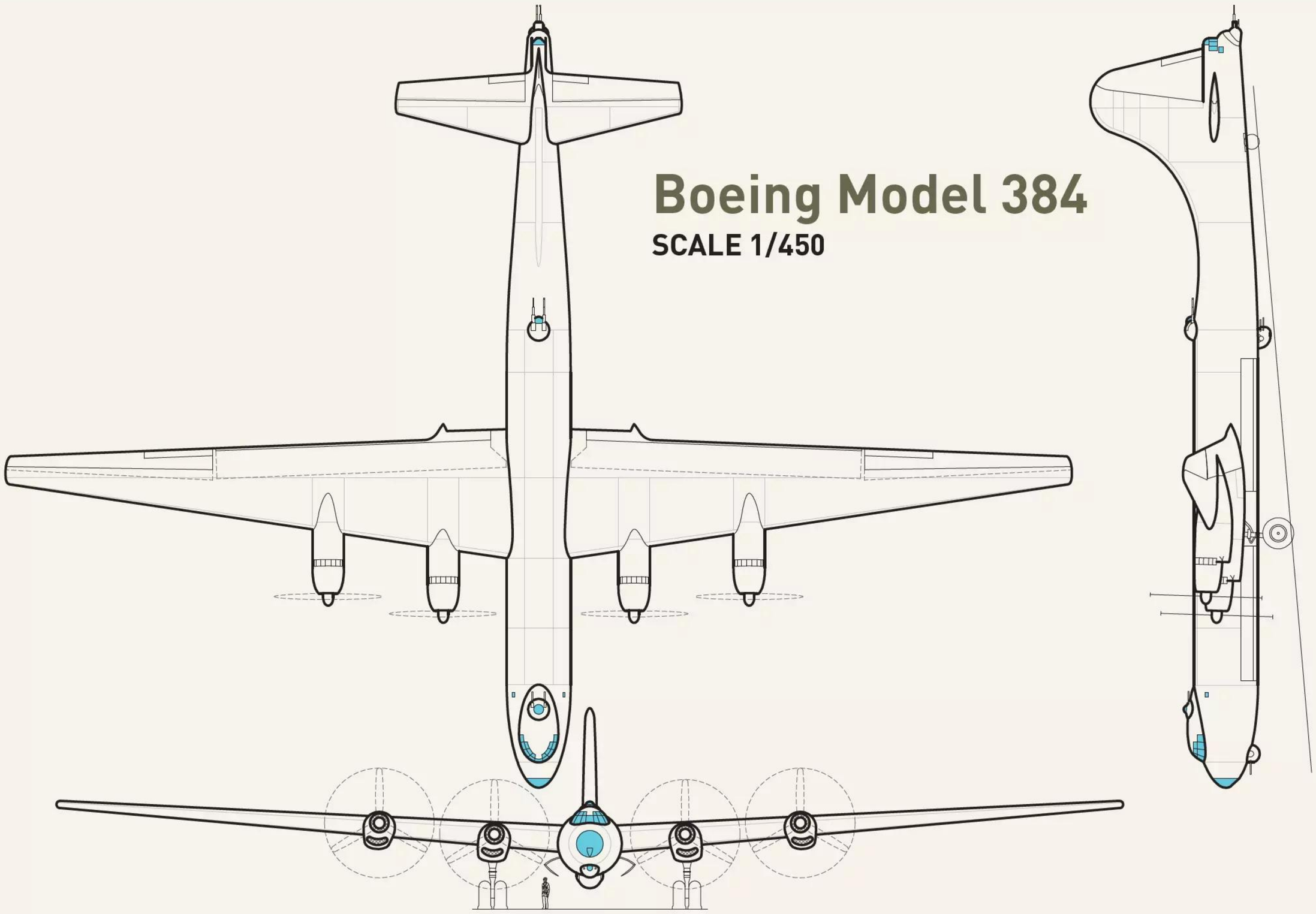

Boeing Model 385

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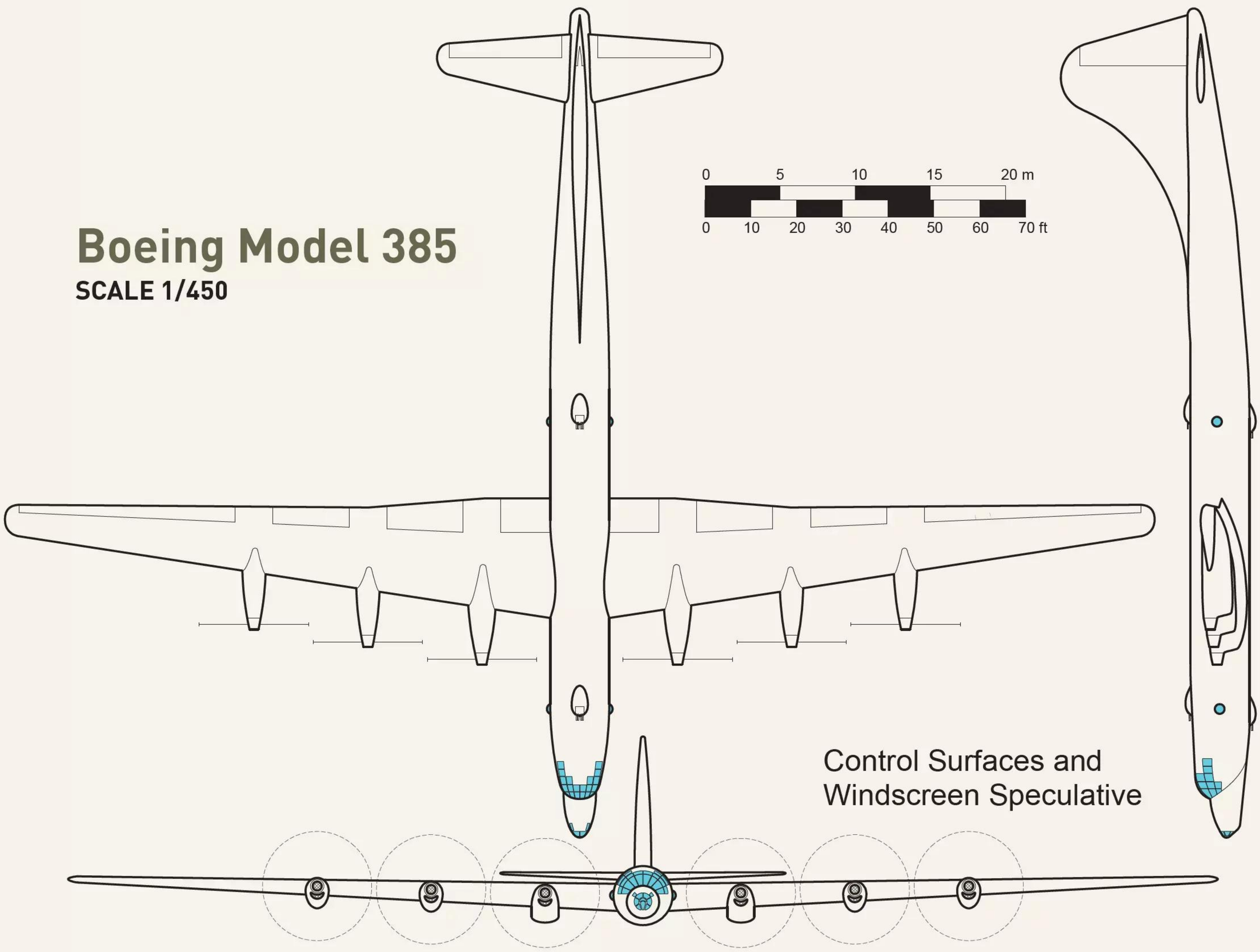


200lb bombs, 48 x 1000lb bombs or 96 x 500lb bombs. For defence it had 14 x .50cal machine guns with 500 rounds each and a single 20mm cannon with 120 rounds. Information on this design is pretty lean.

Model 384, and possibly Model 385 too, were intended as Boeing's official submissions to the USAAC's RFP. But their performance was well below what was required, as well as being submitted somewhat late. It appears that the Army was underwhelmed with Boeing's tender and no further work was done. However, Boeing was deeply involved in production of the B-17 and development of the B-29; neither the Army nor Boeing were likely too upset that the company would be able to focus on the jobs it already had at hand.

Convair B-36 (Model 35)

Consolidated responded to the April 1941 RFP with their Model 35 design. This was a fairly gigantic aircraft that utilized the best aerodynamics of the day as well as novel metallurgy and design to reduce weight. It featured six of the astonishing Pratt & Whitney R-4360 Wasp radial engines, two tractor and four pusher, with the tractor engines in tandem with two of the pushers. These engines featured a corn cob-like arrangement of four rows of seven cylinders (totalling 28) to generate 3,800hp per engine.

The pusher engines were buried partially within the wings and drove propellers well aft of the wing trailing edges. The wings themselves were aerodynamically nothing spectacular, being fairly straight and certainly having a thick root… but they were vast in expanse, with a span of 232ft 6in.

The B-36 remains the longest-span military aircraft ever put into production, though the Model 35 as originally proposed did differ in other important ways from the B-36 as actually built. The tail surfaces were much more like those of the B-24 than the B-29, with oval vertical stabilizers at the ends of the horizontals. The fuselage was a simple tube, though the nose as originally designed was slimmer than actually built, though broadly conventional. What gave the Model 35 its great range was its sheer scale.

By October 1941, the Army Air Force had decided that the Consolidated design was the best one submitted to the RFP, so the following month a contract was signed calling for the construction of two XB-36s. Model 35 evolved as work progressed – the cockpit section became stubbier; the fuselage became more constant-section cylindrical; the defensive armament arrangement changed time and again.

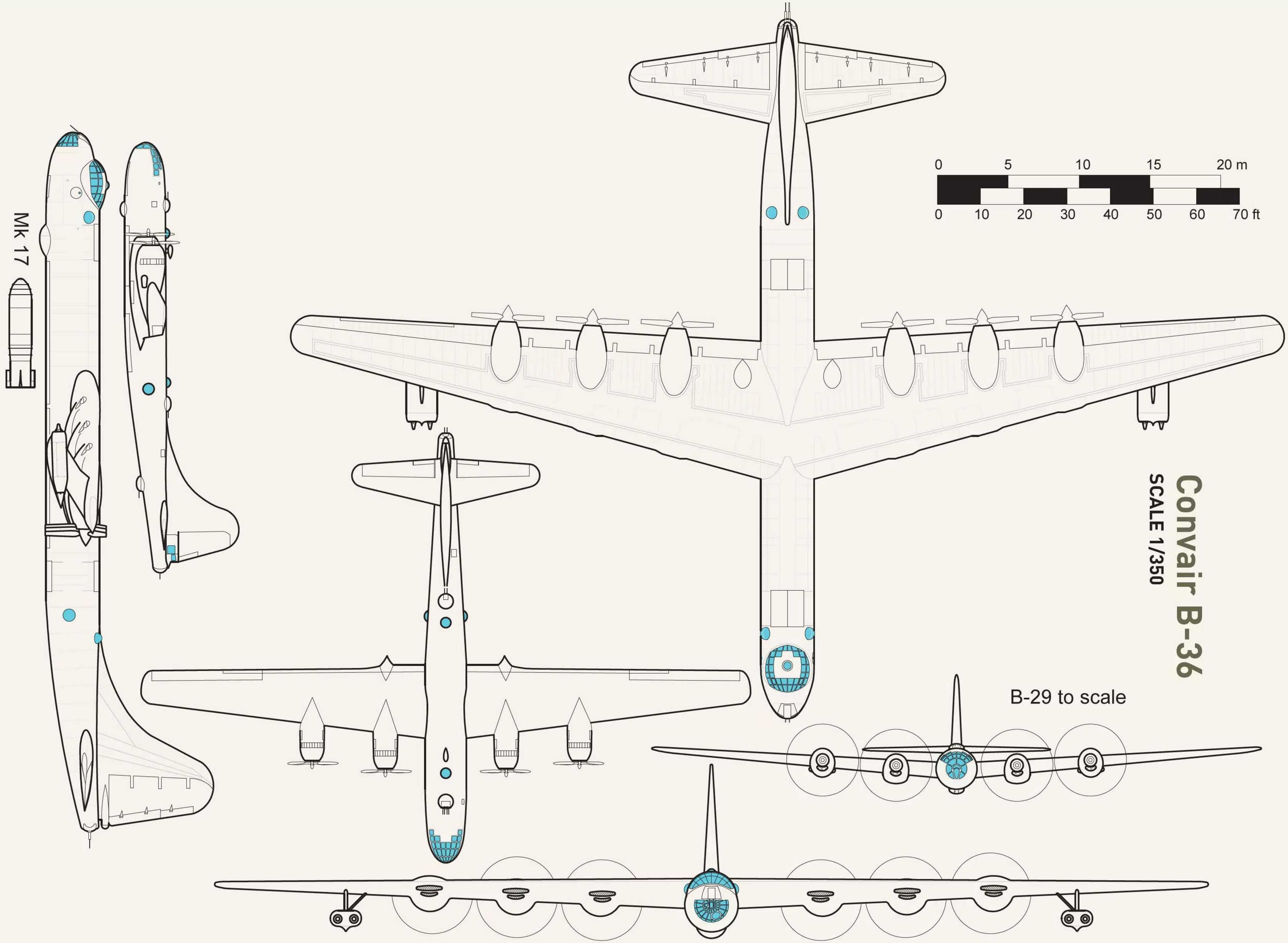
The aircraft eventually changed enough that Consolidated felt that it deserved a new company designation, going from Model 35 to Model 36. Every effort was made to reduce drag; the skin was made as smooth as possible and the six engines become all-pushers. Putting the propellers behind the aircraft ensured that the airflow over the wings would be as clean as possible. The defensive gun turrets, six each with twin 20mm cannon, were stored internally and deployed through doors that slid open, the lowest drag option available. The turrets were controlled remotely using the system pioneered by the B-29.

Progress was slow. In March 1943, well before the first flight of the XB-36, Consolidated merged with Vultee. The new company was often unofficially referred to as 'Convair' until 1954, when it became official. In July 1943, the Army Air Forces ordered a production run of 100 of the B-36 bombers, despite the not-yet-flown XB-36s having run into delays and technical problems. It was now becoming clear that Britain was unlikely to either fall or sign a peace deal with the Nazis – and the war in the Pacific was turning into a horrific slog. The B-29, as well as the B-32 Dominator built as a backup, were also experiencing problems. Troubled as it was, the Army thought that the B-36 might be the only way to strike at the Japanese home islands – hence the production order.

The twin tail became a single vast vertical fin, reducing weight and drag while raising the height of the aircraft. A new directive came in that the bomber needed nose cannon to protect against head-on attack; this necessitated a complete redesign of the forward fuselage, raising the cockpit and giving the aircraft its distinctive and fairly gigantic 'greenhouse' canopy.

The main landing gear was designed to use a single 110in diameter tyre, the largest aircraft tyre in history, and this would fit neatly within the wing. But the single tyre configuration reduced the number of runways the B-36 could land on (without crushing the concrete) to three: Fort Worth, Texas, Eglin Field, Florida and Fairfield-Suisun Army Air Field in California, as well as posing a serious risk to the aircraft if a tyre failed. So the landing gear was redesigned with a four-wheel bogey and more realistic 56in tyres. This arrangement was more practical but also thicker; as a result the wing was redesigned to have fairings both above and below to cover where the wheel projected through the wing outer mold line.

At last the single XB-36 was completed and rolled out, and finally flew on August 8, 1946, a year and two days after the atomic bombing of Hiroshima. The aircraft had missed the war by a large margin and proved to be creakingly slow with a top speed of only 230mph. The XB-36 had the original low-set cockpit, no defensive armament whatsoever and the single large diameter main wheels. Still, the B-36 was all the Army Air Forces, shortly to become the USAF, had as far as intercontinental bombers went. The first B-36A with the final landing gear type, armament positions (though not the actual armament) and raised cockpit first flew on August 28, 1947. The second



Convair B-36

SCALE 1/350

XB-36 only flew for the first time on December 4, 1947, almost six years after Pearl Harbor. It was built closer to production standard with the redesigned cockpit and full set of cannon, but still had the single main wheel, and was designated YB-36.

The B-36s began entering Strategic Air Command service in June of 1948. Performance was improved compared to the XB-36: after an 8,000ft takeoff run with a 10,000lb bomb load they had a radius of action of 3,880 miles and a maximum speed over the target of 345mph at 31,600ft. This fell well short of the 12,000 mile range they had been meant to deliver, but at least it could almost strike Berlin from New York City – though Berlin was no longer a target by 1948.

The B-36B, first flying on July 8, 1948, improved upon the B-36A in many areas, learning the lessons that the A-model taught. And it did at last come equipped with the defensive armament planned. The B-36B began SAC service in November 1948 and test flights showed that it could carry out a simulated mission with 10,000lb of bombs with a total range of 8,100 miles; truly an intercontinental range. It did so at only 236mph though, a speed fairly described as 'lumbering'. Several proposals for modifying the B-36 with variable discharge turbine or turboprop engines were made but these would have required massive wing modifications and in the end failed to come to fruition. Convair proposed a simpler solution to boost the top speed of the B-36 in October 1948: bolt on some turbojets. The B-36D model was delivered with four General Electric J47 turbojets in twin engine pods – basically identical to those used on the Boeing B-47 except without the provisions for the deployable outrigger landing gear.

It came as no surprise that the additional jet engines substantially improved performance. They reduced the takeoff run by 2,000ft, raised the ceiling to 43,800ft and the top speed at 36,200ft to 406mph. All existing B-36Bs were then converted to B-36D standard.

The B-36D finally gave the United States a truly operational intercontinental strategic bomber. It was able to hit virtually any target on earth, dropping any weapon in the US arsenal. This included not only the T-12 44,000lb bomb but also the 15 megaton Mk 17 thermonuclear bomb. At 41,400lb, it was the heaviest nuclear weapon the US ever produced. It was not a convenient device.

Boeing Model 444 A

A May 1945 design, Model 444A was a long-range strategic bomber powered by four large turboprop engines, each with 20ft diameter counter-rotating propellers. Resembling a scaled up B-29, for defense it had four remotely controlled machinegun turrets mounted fore and aft on the sides of the fuselage. Little further data is available.

MCD 392

Aircraft design in the US was not left solely to the aircraft manufacturers during the Second World War. The US Army Air Forces designed aircraft as well – not necessarily to be built, but to illustrate the sort of aircraft it needed or would soon need. One such design was the MCD 392 (Material Command Design 392), produced in 1944 at Wright Field Aircraft Laboratory. This appears to have been more a design study to keep the Wright Field engineers on their toes, rather than an effort to produce a detailed design for production and service.

The MCD 392 was intended to show what kind of aircraft could fulfill a global bombardment role. To that end, it was a gigantic machine, powered by eight Allison V-3420 engines. All these unconventional powerplants were buried in the wing, driving either tractor or pusher propellers, and the thickness of the wing allowed crew to access them for maintenance or repair.

The propellers were contra-rotating, with two engines feeding into a common gearbox to provide power. Each propeller, tractor or pusher, was at the end of a nacelle that extended past the other wing edge. They terminated in ball turrets, each with a quartet of .50cal machine guns. The gunners could access the rest of the aircraft via walkways in the nacelles and wings. Additional ball turrets were located in the nose and tail. This arrangement was expected to provide adequate coverage – though directly above and below, as well as to the side, would have had poor coverage unless those turrets were capable of surprising degrees of traverse and elevation.

Total defensive armament was 16 x .50cal machine guns, each with 1000 rounds, and eight 20mm cannon, each with 300 rounds. The bomb load was only partially contained within the fuselage, the inner portions of the wings also able to hold a substantial payload. Illustrations show a crew of 15.

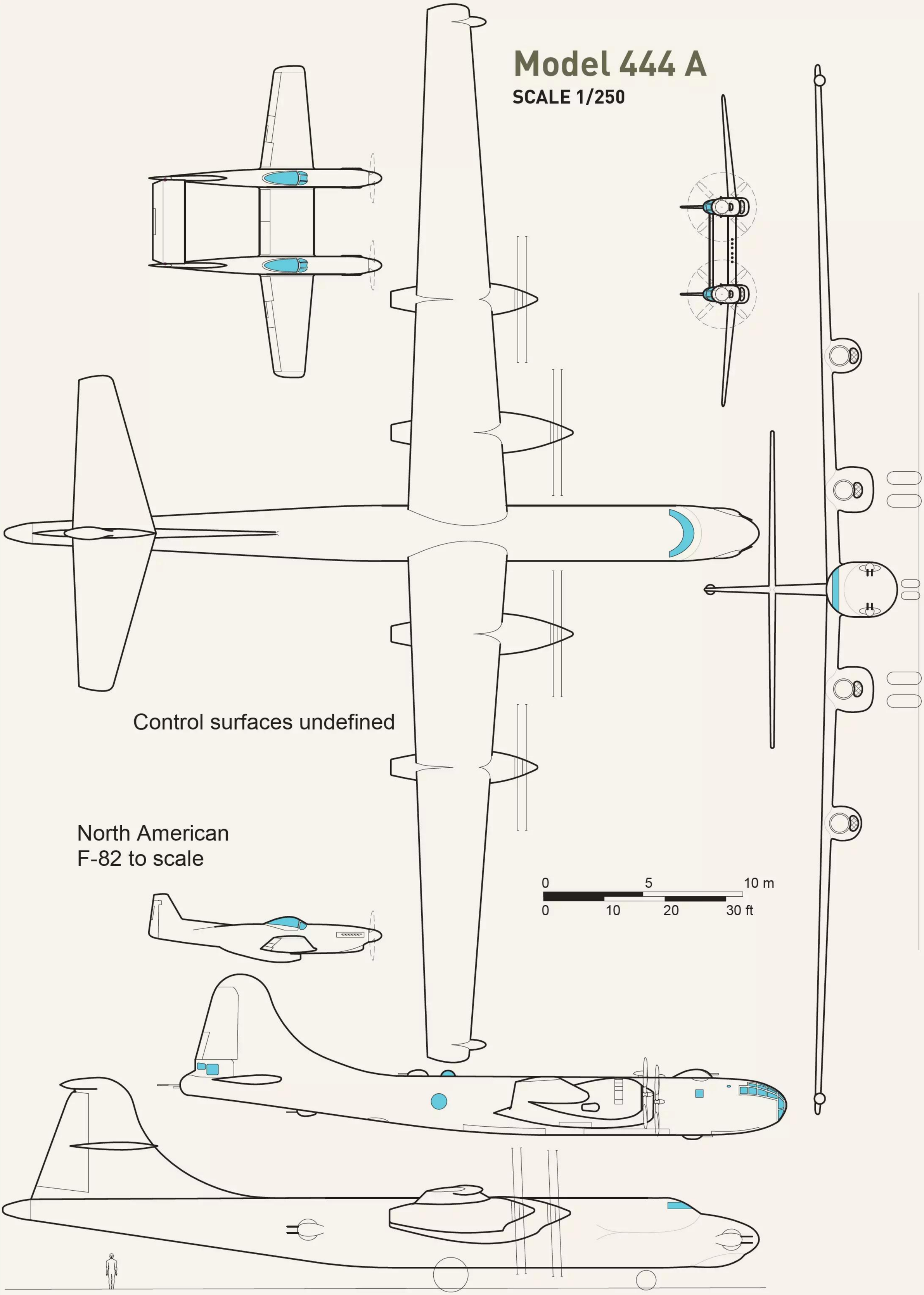
The MCD 392 seems like an oddity. It was intended to bomb Tokyo, even though that city was already in range of bombers flying from captured Pacific islands by the time it was drawn up. And while its range and payload capacity were vast, its ceiling was shockingly low and its top speed abysmally slow. Its layout, propulsion systems and aerodynamics represented early-war thinking and it had no future in a jet-powered post-war era.

Early Postwar Concepts

When the Second World War ended, the fragile alliance between the Western Allies and Stalin and the Soviet Union quickly fractured. Clearly this was not, as had been hoped, the end of all wars. So the American military and aviation industry kept on designing and innovating, knowing that sooner or later war would come roaring back. And even though the United States had at that moment a massive air force, it was also clear that the

Model 444 A

SCALE 1/250



Control surfaces undefined

North American
F-82 to scale

M.C.D. 392

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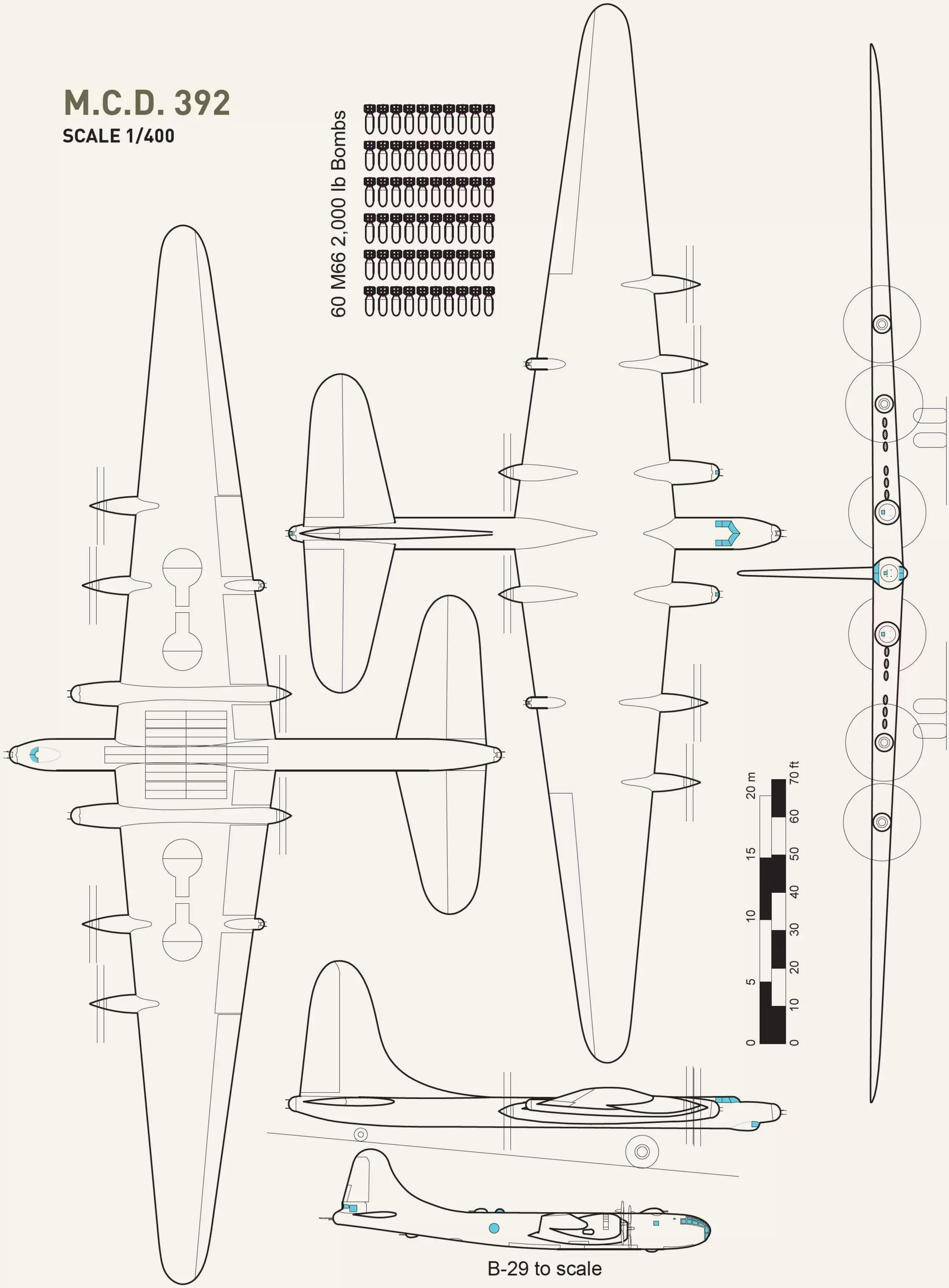

Consolidated Vultee High Performance Patrol Landplane

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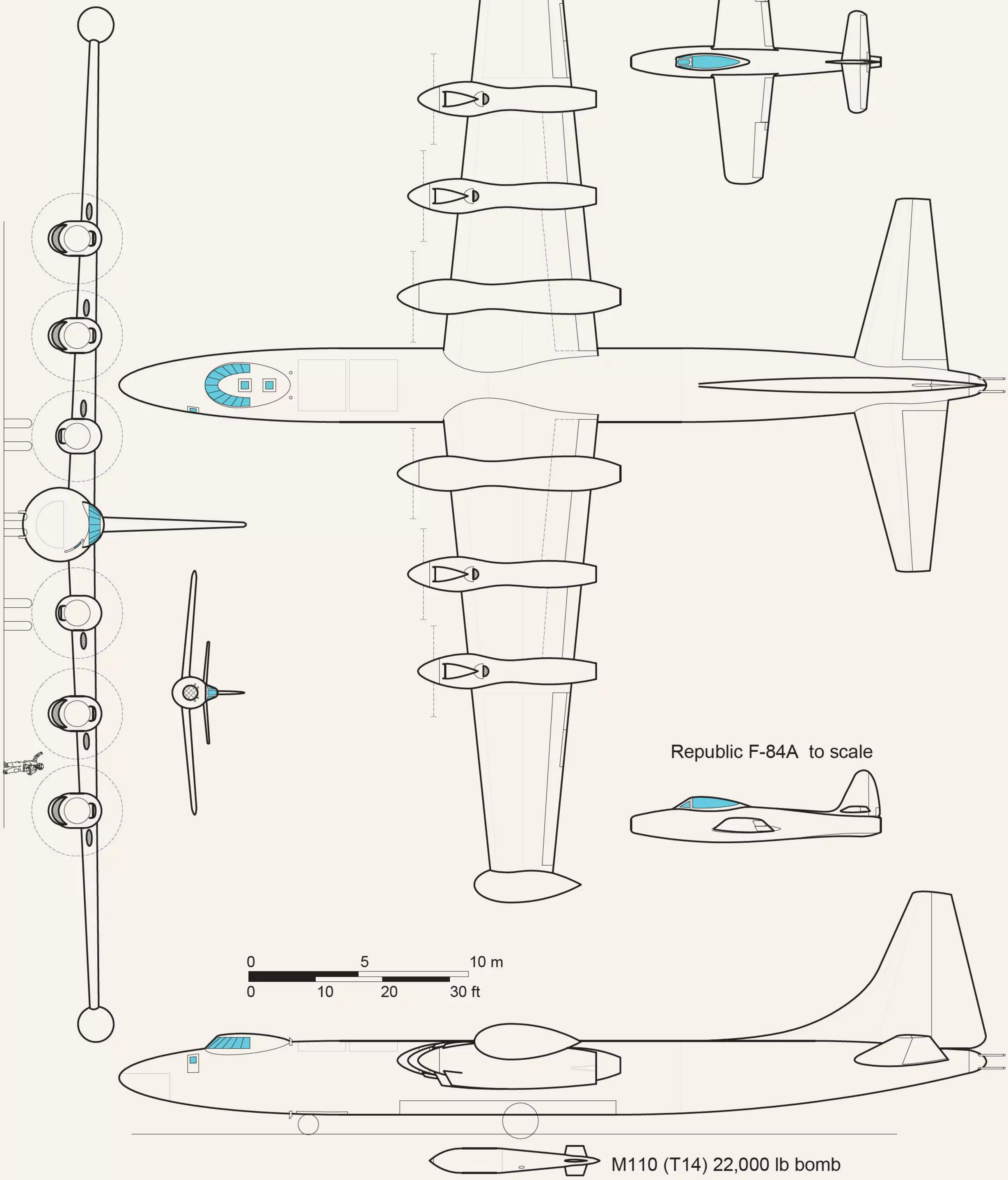

vast bulk of it was already well beyond obsolete. Jet engines, turboprops, rockets and ramjets were the way of the future, not piston engines. Every single airplane the US had would need to be replaced… and every American aviation company wanted to be in on that. Designs were produced both to government specification and by company internal desire.

Consolidated Vultee High Performance Patrol Landplane

The US Navy issued a requirement in January 1946 for a heavy land-based patrol bomber and Consolidated Vultee responded two months later with a turboprop-powered design.

The aircraft was intended to fly at high altitude and scan the ocean for enemy vessels using radar in the lower half of the nose. Photographic reconnaissance was a secondary role, along with the launch of 'special weapons' against targets of opportunity. 'Special weapon' generally meant 'atomic bomb' at that time but the use of A-bombs against targets of opportunity – in this case, likely ships or subs – seems vastly expensive overkill. Instead, the term more likely referred to guided munitions such as the VB-6 Felix infrared guided anti-ship bomb or the ASM-N-2 Bat radar guided anti-ship glide bomb.

The inboard profile diagram shows the aircraft armed with a 22,000lb M110/ T-14-type giant bomb; while the smaller 'Tallboy' bombs were used by the British to sink the German battleship Tirpitz, the Tirpitz was essentially a fixed target. Hitting a moving vessel with a 'Grand Slam' would be challenging to say the least… but there are few ships that would not be effectively rattled by the impact of such a device dropped from 40,000ft.

The baseline design was very much a transitional concept between wartime convention and rapidly evolving postwar technology. It had shoulder mounted straight wings, conventional tail unit, propellers and engines on the wings, sharing some traits with the XB-46, then under development. But the engines were what set it apart.

At first glance, the High Performance Patrol Landplane appears to have six tractor engines. And indeed it did have six turboprop engines in separate nacelles, each driving a 14ft 7in diameter four-bladed propeller. But the intermediate and outboard nacelles were also fitted with a separate turbojet engine for takeoff thrust and high-speed performance, bringing the total engine count to ten.

In each nacelle the turboprop engine was mounted aft of the main spars, driving the propeller via an extension shaft; each turbojet was located at the rear of its nacelle, above the turboprop.

At the tail was a remotely controlled turret with four 20mm cannon, each with 400 rounds. The gunner doubled as the radio operator and, as with the rest of the crew, occupied the single pressurized compartment at the front of the fuselage. Additional remotely controlled turrets sat at the wingtips, each with two 20mm cannon with 400 rounds each. It's unclear whether the guns were trained forward or aft, however. Fuel was contained within a series of fuselage cells.

An alternate design was put forward at the same time, deleting the wingtip turrets and going with four more powerful Wright turboprops, each with 18ft diameter contra-rotating propellers. This design was clearly derived from the Heavy Bombardment Airplane of about a year earlier (see below), differing largely in being shorter and only having defensive guns in the tail. It may be that the baseline design was also derived from an earlier Army bomber study; this would explain the Grand Slam.

The High Performance Patrol Landplane was by no means an intercontinental strategic bomber, but it had features that would be useful for such an aircraft. And, importantly, Consolidated Vultee would soon base its B-52 competitor on it.

The contest

The Engineering Division at Wright Field recommended in August 1944 that a study for a B-36 replacement be undertaken in 1946. Work on this new heavy long-range bomber would, it was suggested, occur between 1947 and 1949. It would be more advanced than the as-yet unflown B-36, taking advantage of recent developments in turbojet and turboprop engine technologies.

The advent of jet interceptors was making the B-36 look vulnerable – and existing jet escort fighters lacked the range to defend it over enemy territory. So a new generation of intercontinental bomber was needed that could fly both high and fast. Prior to April 1945, the Army Air Force published requirements for a new heavy bomber which included top speed of 475mph with half fuel at 35,000ft, 375mph average speed, 40 x 500lb bomb load, 40,000ft ceiling, 15,000ft ceiling on half engines and 5,500 mile range.

This was extremely aggressive for the time. Most aircraft companies declined the challenge, seeing the AAF's requirements as beyond the state of the art. However, one design has been found that was intended to fill that role.

Consolidated Vultee Heavy Bombardment Airplane

Consolidated Vultee designed a turboprop bomber in March 1945 with a view to meeting the AAF's requirements. With the available engines being somewhat disappointing, the design was based on hypothetical engines using data provided by the Wright Aeronautical Corporation. The overall configuration was conventional; it looked like nothing so much as an XB-46 scaled up

and given four separate turboprops. As with the XB-46, the wings were narrow chord and unswept; data from German swept wing studies had not yet come in.

The turboprop engines were assumed to be Wright gas turbines with regeneration, producing 5,500hp. Each would drive a 15ft diameter six-bladed counter rotating propeller. The inboard nacelles had a bulbous fairing on the underside into which the dual main wheels would retract, the dual nose wheels retracting beneath the pressurized crew compartment. The forward crew compartment contained the pilot, co-pilot, two radar bombardier navigators, the flight engineer and one radio operator/fire control officer.

Likely the most unconventional design features were the four large diameter remote-controlled turrets on the sides of the fuselage. Their guns, pivoting near the ends of their barrels, were located within the fuselage so that the turrets presented the same low drag no matter where the guns were pointed.

Despite this unusual arrangement, it seems that the four side turrets and the tail stinger would have provided good coverage. All five positions had two .50cal machine guns; the forward turrets had 500 rounds per gun, the aft turrets 800 rounds per gun and the tail had 1,000 rounds per gun. Three fire control operators were housed in a pressurized compartment near the tail, connected to the forward compartment by a long pressurized tube.

There is no evidence that Consolidated Vultee actually submitted the design for consideration – likely being too preliminary to be turned in. It is known from a Consolidated Vultee design summary, rather than a proposal or detailed engineering schematics. While the performance estimated for the aircraft certainly exceeds the requirements, it seems rather implausible that it would do so in practice. Further examination by CVAC or perhaps AAF staff may well have found it fundamentally flawed.

No other designs are known to have been created specifically to fit the overly aggressive AAF requirements. A rethink therefore produced more modest requirements in January 1946: 450mph top speed at 35,000ft, 300mph average speed, 40,000ft ceiling, 15,000ft ceiling on half engines, 5,000 mile range with 10,000lb of bombs, 7,500ft take-off run to clear 50ft obstacle at gross weight, 4,500ft landing distance over 50ft obstacle at gross weight minus droppable fuel and bombs.

This was still more than could be asked of the turboprops and turbojets of early 1946. It was believed that the development of a turboprop engine able to support such an aircraft would require ten years of development, not the mere handful the RFP called for. Rather astonishingly, the Army wanted an aircraft able to carry – for an undetermined but necessarily shorter range – a single 80,000lb bomb.

The Air Technical Service Command issued another RFP with basically the same requirements the following month… but called only to 'approximate' the previous requirements. This recognition of the need to compromise in order to get a viable aircraft, not necessarily a perfect one, was enough to get airplane manufacturers interested.

Boeing, Consolidated Vultee and Martin submitted their designs in April.

Martin Model 236

From a report dated April 23, 1946, the Martin Model 236 Heavy Bombardment Airplane was conventionally laid out, with a cylindrical fuselage, long, straight shoulder-mounted wings and a conventional tail unit. Propulsion was by means of six wright Aeronautical Corporation T-35-1 turboprop engines driving six-blade 16'8" diameter contra-rotating props.

While conventional in general configuration – the fuselage and cockpit bore a definite resemblance to the aerodynamically unaggressive Martin XB-48 - the M-236 did have one feature that stood out. The B-29 had proven the practicality of remotely controlled defensive turrets; the M-236 expanded on that to include remote turrets at the wingtips. Large pods, reminiscent of wingtip fuel tanks often employed by early jet aircraft, contained a total of eight 20mm cannon each. Two cannon fired forwards, to aft and four projected to the side. The fore and aft cannon were fitted in ball turrets, while the side guns would move and aim via slots. Curiously, these seem to have been the only defensive guns… none in the traditional nose or tail positions, nor any on fuselage turrets. The gunners would be located within the fuselage, with aiming assisted with radar. The bomb load could be anything from 63 500-pound general purpose bombs to 49 1000-pound bombs to a single 44,000lb T-12 'Cloudmaker.'

Thought was also given to powering the M-236 with four Wright Aeronautical Corporation GTC-1 gas turbines, each with 17' diameter counter-rotating props. The basic crew was ten, but an additional six relief crew would be carried due to the long mission durations expected. Landing gear came in the form of a substantial "bicycle" arrangement with four large wheels ahead of the bomb bay and four aft of it, with small outrigger stabilizing gear that would lower from the outboard engine nacelles.

Consolidated Vultee Long Range Heavy Bombardment Airplane

The Consolidated Vultee design was certainly unusual. It was clearly derived from the Heavy Bombardment Airplane of a year earlier and a number of important design features had been carried through – but there was one clear difference. The Long Range Heavy Bombardment Airplane had distinctly forward-swept wings. This was a

Consolidated Vultee Heavy Bombardment

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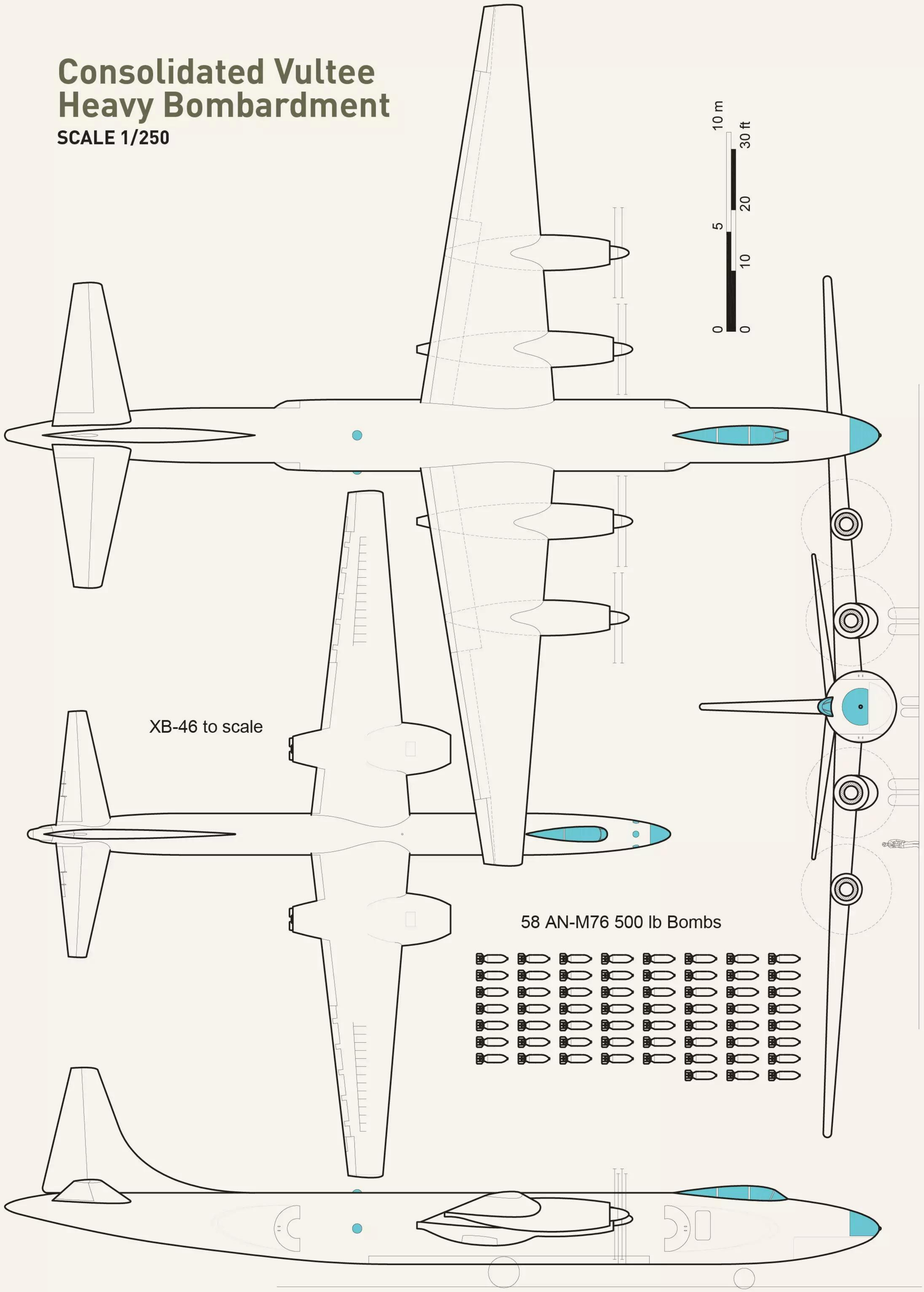

Martin Model 236

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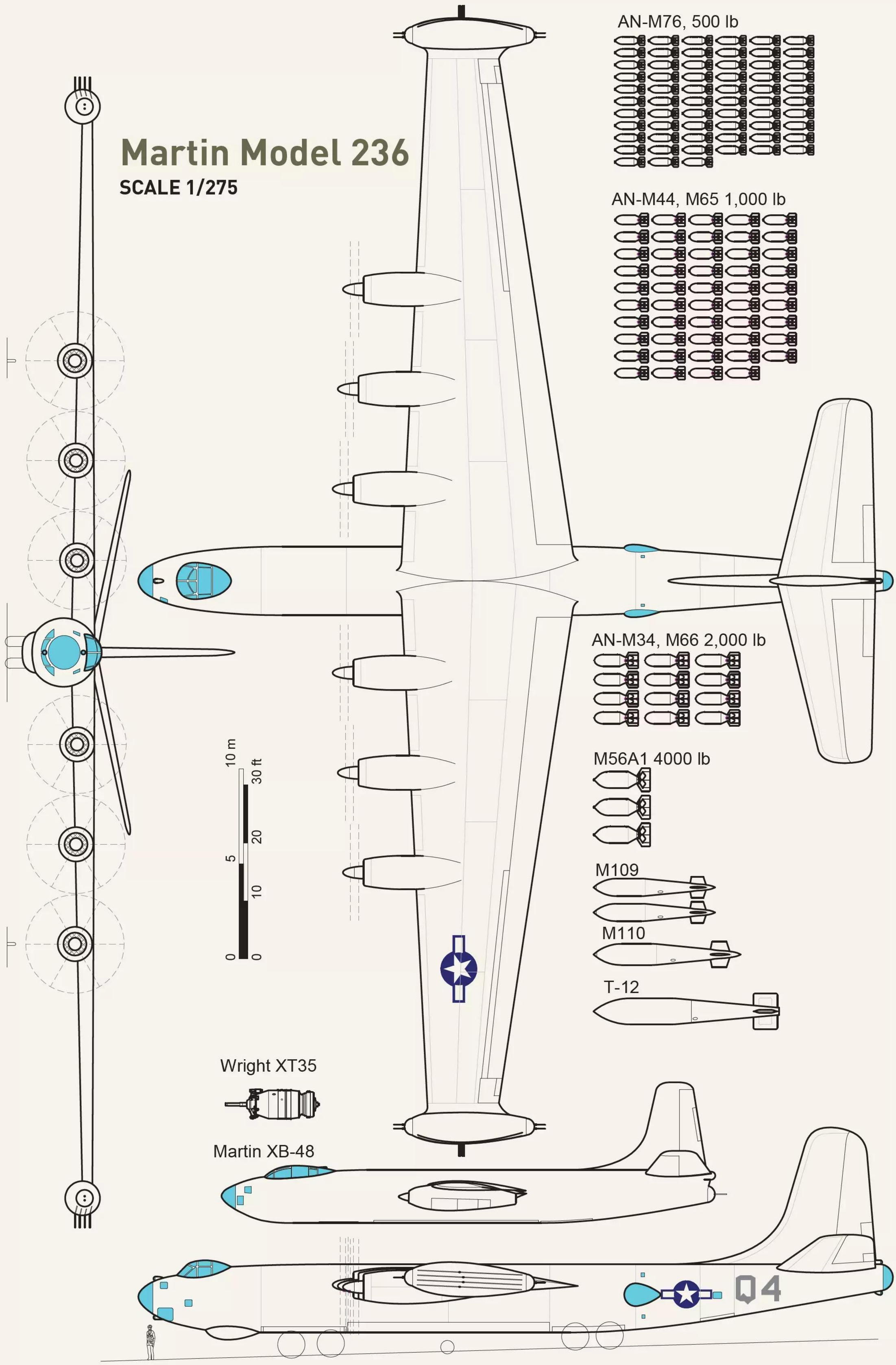

Consolidated Vultee Long Range Heavy Bombardment

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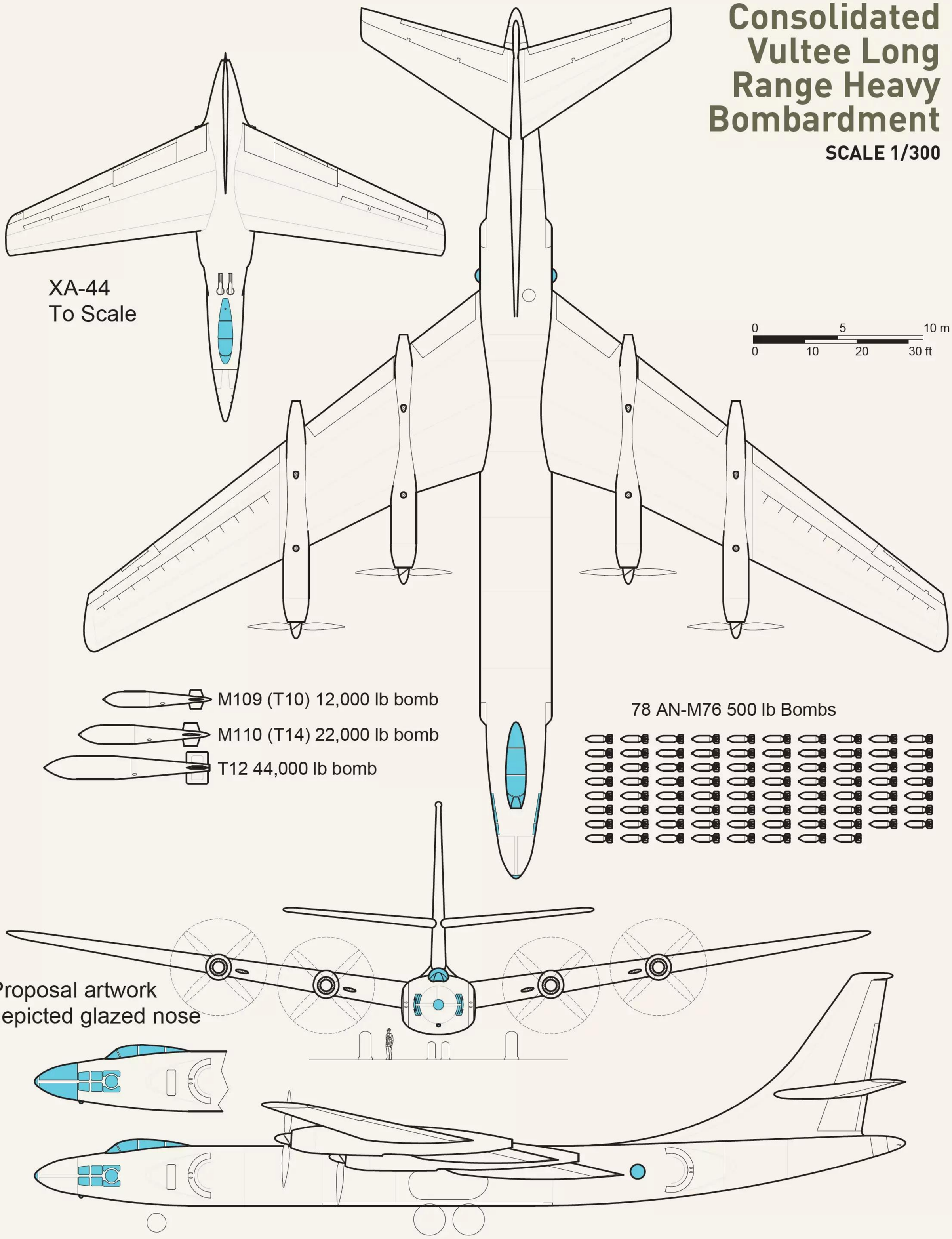

concept that fascinated Consolidated Vultee at the time; concurrently the company was working on the XA-44 ground-attack aircraft – a rather odd tailless design with forward swept wings and three turbojets. Forward sweep conveys the same high-speed drag reduction as aft-sweep while moving the centre of lift forward. This meant the main spar was further aft – freeing up space in the forward fuselage for equipment, weapons or other features.

Airflow over a swept wing is not purely fore-to-aft, but it is directed spanwise towards the rearmost part of the wing. With a conventional aft-swept wing this means that the airflow heads towards the wingtip, but with a forward swept wing the air heads inboard, towards the wing root. This is a useful feature during landing and other slow speed flight: the forward swept wing will tend to stall first at the wing root rather than the tip as airspeed drops and angle of attack increases. Aft swept wings that stall first near the tips tend to lose aileron effectiveness, since the ailerons are at the wingtips, but forward swept wings retain control.

Unfortunately there is a concern that has always largely negated the value of forward swept wings: as the angle of attack of a wing increases, forces build up on its tips. With a forward swept wing, those forces are trying to bend the wings up and over. In the best case, this will result in the wingtips flexing upwards; in a worse case they take a permanent set, and in the worst case they break. As the tips twist upwards, they generate more lift, which bends them upwards even more. A feedback loop can set in, leading to disaster. In any case, the wingtips twisting up even a little bit can also cause flow instabilities.

Before the Grumman X-29 demonstrated forward swept wings made out of graphite-epoxy composites, wing structures strong enough to withstand the forces trying to warp them tended to be unenviably heavy. A handful of aircraft have entered production with forward swept wings, such as the Hamburger Flugzeugbau HFB 320 Hansa Jet. This 1960s business jet had a forward swept wing for a singular purpose: the spar passed through the rear of the fuselage rather than the front. This allowed for a passenger cabin larger than those contemporary competitors such as the Learjet.

The root stalling advantages of forward swept wings convinced Consolidated Vultee's designers to give their big bomber this unusual feature. The aft location of the spars also permitted the long bomb bay to run through the middle of the fuselage without structural interference. The main landing gear wheels were stored within the fuselage, while the landing gear legs were kept just behind the leading edge of the wing roots.

The wings were bisected by four nacelles. Each of these held a Wright T-35 turboprop up front driving a four bladed propeller. Directly behind each turboprop was a GE TG-180 turbojet; these would be used only intermittently, such as during takeoff and during high-speed dash over the target – where they would add about 115mph to the top speed at 35,000ft. This was considered an interim solution; it was hoped that eventually, when new propulsion systems were ready, the eight engines could be replaced with four.

For defence, the bomber had four of the unconventional flush turrets that Consolidated Vultee had designed into several other bombers, including the Heavy Bombardment Airplane. Each had two 20mm cannon, as did the tail turret. A wide range of offensive payloads were possible, including: one 80,000lb bomb; one 44,000lb bomb; one 22,000lb bomb; two 12,000lb bombs; seven 4,000lb bombs; 18 x 2,000lb bombs; 36 x 1,000lb bombs; 78 x 500lb bombs; and, for the maximum range design condition, 20 x 500lb bombs. Total range at maximum gross weight and with one 80,000lb bomb was just over 4,000 miles, or around 9,000 miles with a 10,000lb payload.

The crew were split into two locations. The pilot, co-pilot, flight engineer, radar bombardier-navigator and optical bombardier-navigator sat in a pressurized compartment at the front of the aircraft, while three gunners sat side-by-side in a pressurized compartment near the tail. The crew could pass fore and aft through a pressurized tunnel, much as they would be able to do in the B-36.

The Long Range Heavy Bombardment Airplane did not pass Army Air Forces muster. Doubtless the dubious nature of forward swept wings had more than a little to do with it, along with the fact that Convair was at that moment already deeply involved with development of the B-36.

Turboprop Boeing B-29

Along with the Model 444A, Boeing studied several turboprop powered strategic bombers prior to this contest. A single photograph is known to exist of a large model of a B-29 modified with four turboprop engines, each with contra-rotating pusher propellers. This was likely a wind tunnel model. The date of this design, along with the identity of the engines, is currently unknown, but it's possible that this was an early study for an improved B-29 capable of higher speed.

Boeing Model 461

This 'Patrol Landplane' dated from June 1946 (paradoxically, the Model 461 seems to have been designed after the Model 462) is suspiciously similar in layout and concept to the somewhat earlier Martin Model 236. While still very much a Second World War era plane, with straight wings and a stereotypical war-era Boeing vertical tail, the design is starting to trend in the direction of postwar subsonic Boeing bomber design. The cockpit

Turboprop B-29

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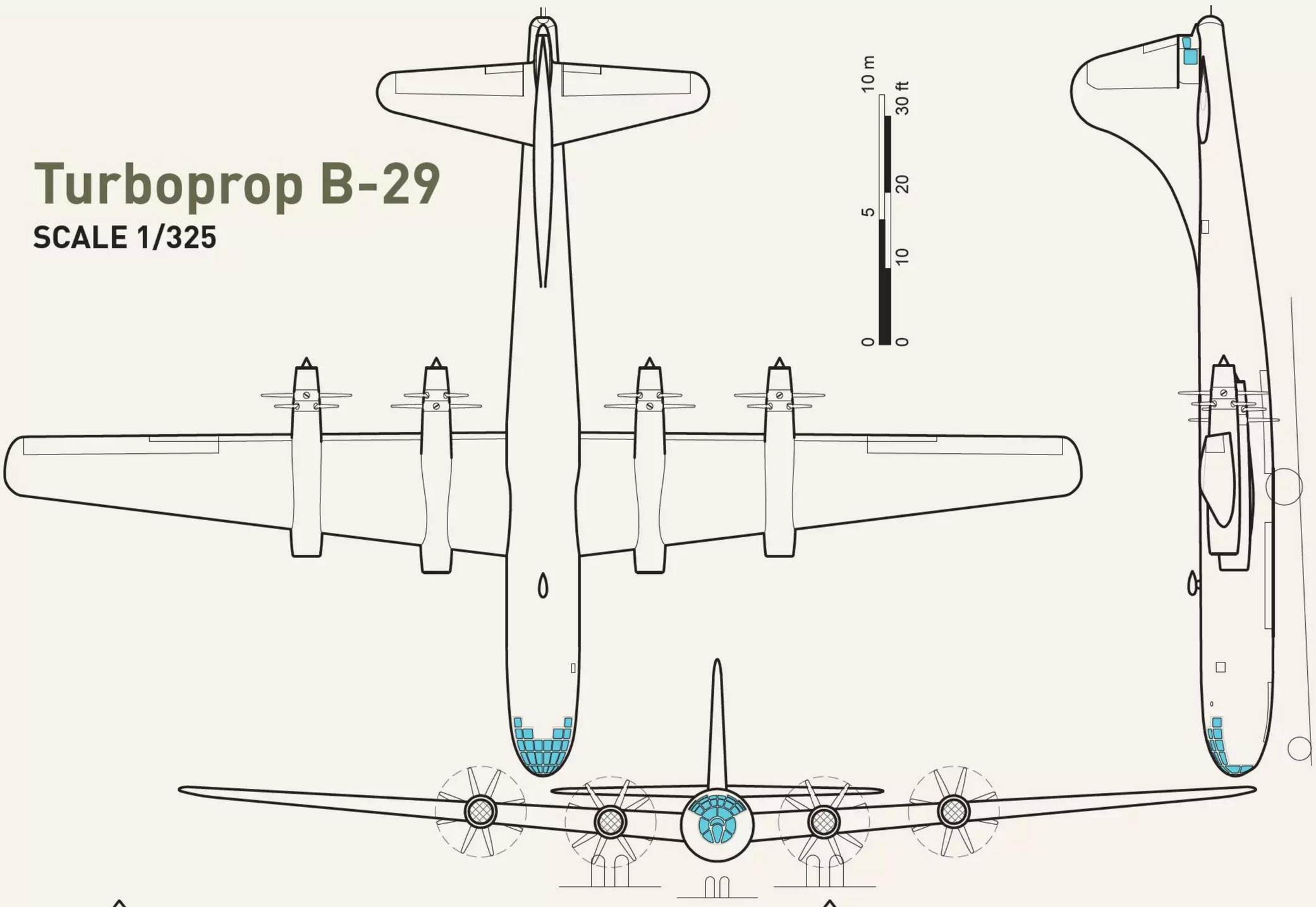

Boeing Model 461

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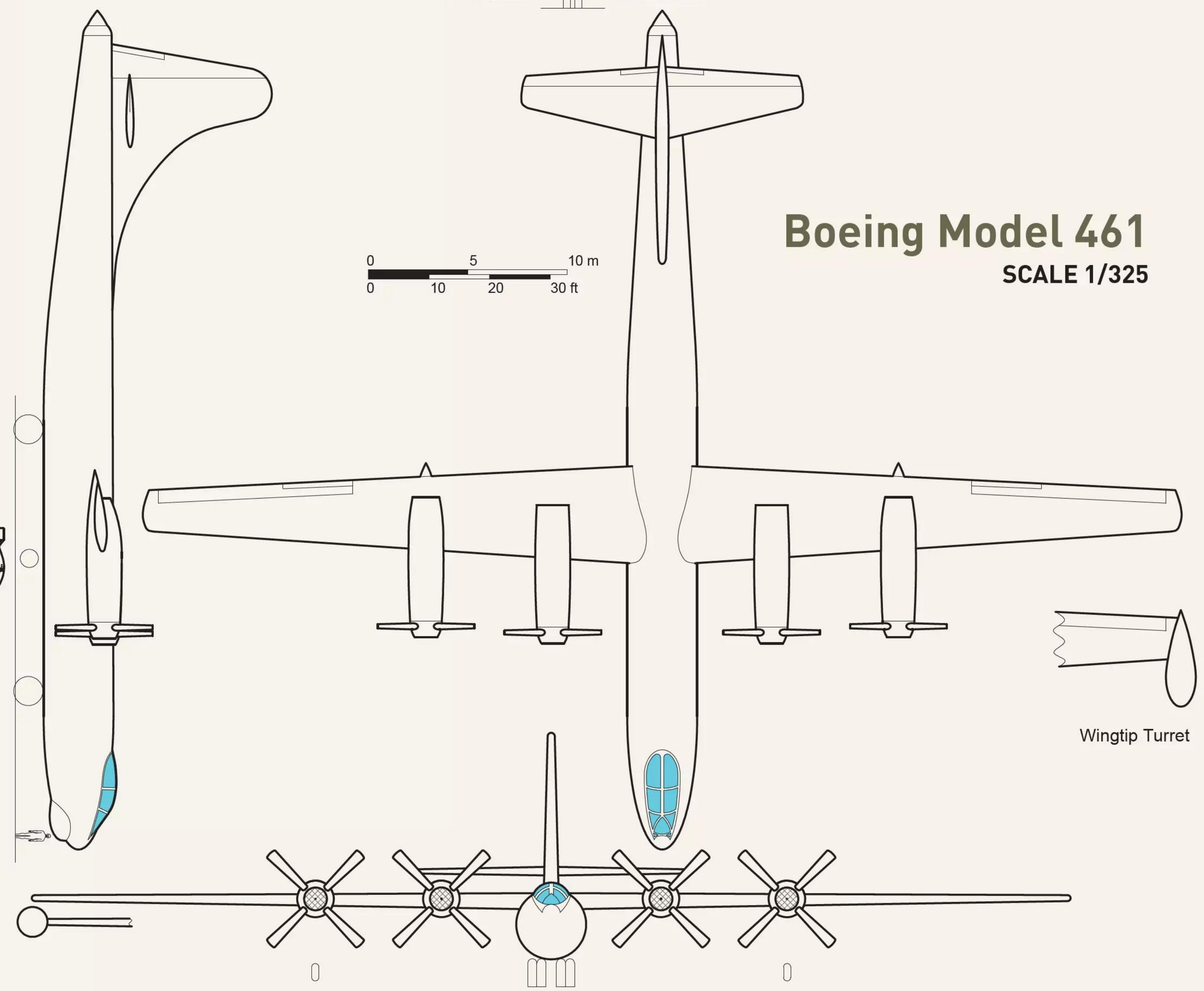
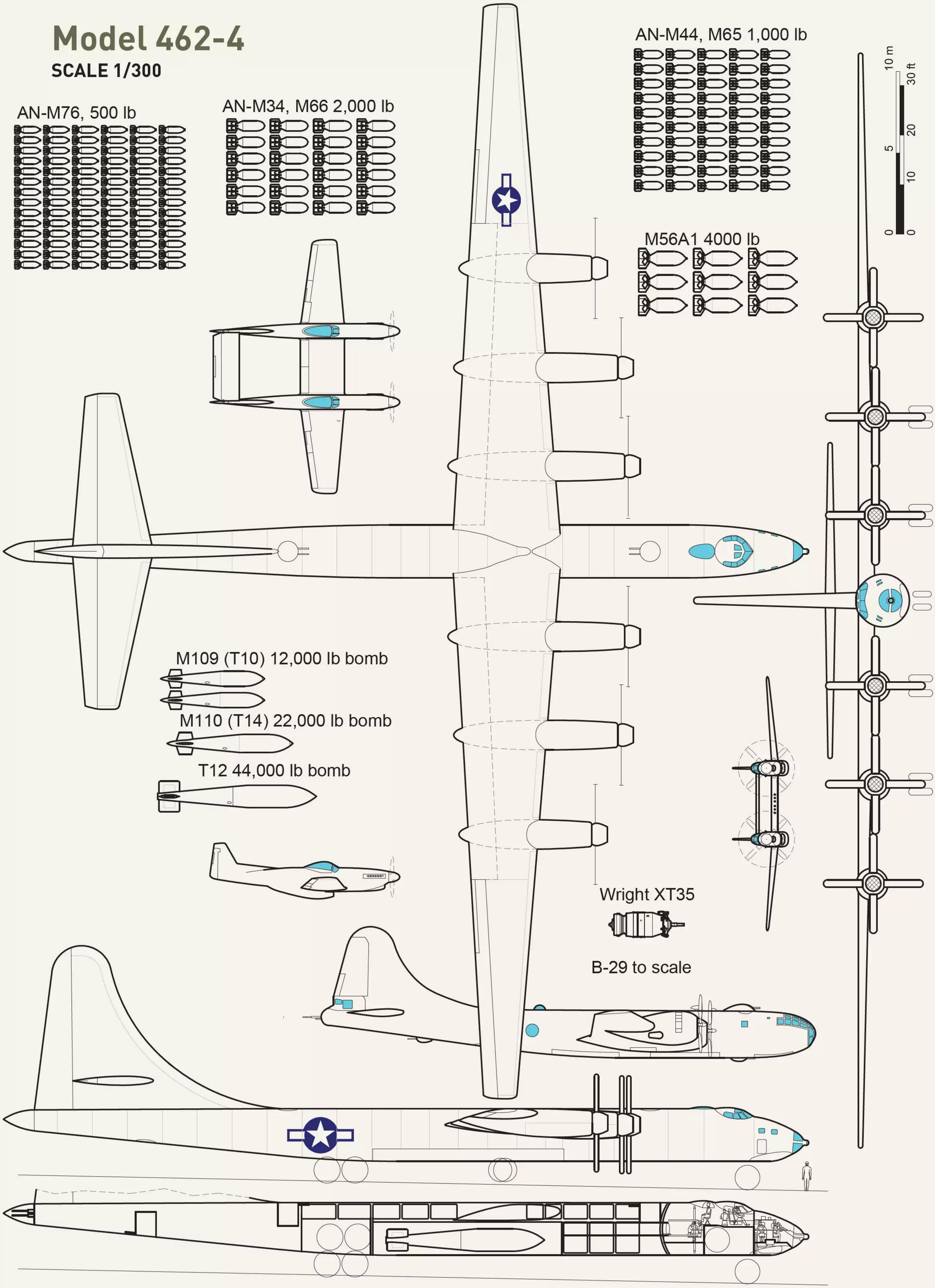


Model 462-4

SCALE 1/300



is more modern, the engines are turboprops and the landing gear is located directly under the fuselage, with relatively small stabilizing outriggers further out under the wings. A large radar dome is visible under the nose, for navigation and bomb-aiming.

Weapons load, apart from total weight (39,400lb) is unknown, but by mid-1946 atomic armament can be assumed. At the time, only the 10,300lb Mark III ('Fat Man') bomb would have been available and the Model 461 would have been able to carry three with room to spare. Defensive armament included a tail turret, remote controlled by the crew in the front of the aircraft. Thought was also given to podded turrets on the wingtips, details unavailable, though undeniably similar to those of the Martin Model 236, at least in concept. A slightly later artist's impression of a six-engined Model 461 shows nine conventional bombs, probably four thousand pounders.

Boeing Model 462

Boeing's April 1946 response to the long range heavy bomber RFP was Model 462, a large aircraft of conventional layout with six turboprops hanging under the shoulder-mounted straight wing. While it bore some faint resemblance in parts to the B-29, unlike several earlier aircraft it was not obviously a direct descendant of that aircraft. The cockpit was entirely different, with a slightly raised canopy for a pilot and co-pilot sitting side by side and a relatively long, sloping forward fuselage leading to a Plexiglas nose cap for the bombardier.

The aircraft had six Wright T-35 turboprop engines, each generating around 5,500hp while turning 20ft diameter four-bladed propellers. The forward sections of the engine nacelles were all identical, from propellers to engines to fairings, connections and mountings. This would simplify and speed maintenance; a single assembly could be bolted on to any of the six positions. The inboard and intermediate nacelles containing dual-wheel main landing gear bogies. A retractable nose wheel completed the landing gear.

Four turrets with two 20mm cannon each were provided for defence, submerged within the fuselage until needed. Two were directly above/below each other just aft of the pressurized crew compartment, one was atop the rear fuselage just ahead of the vertical stabilizer's leading edge extension, and the last was below the rear fuselage closer to the tail. A fifth defensive position, a tail stinger, had four 20mm cannon. Two gunners sat to the rear of the crew compartment, equipped with a total of four periscopes… two above the fuselage, two below, offset to right and left.

Possible bomb loads included a single 44,000lb bomb; two 22,000lb bombs; three 12,000lb bombs; nine 4,000lb bombs; 24 x 2,000lb bombs; 50 x 1,000lb bombs or 84 x 500lb bombs. A 10,000lb 'special bomb' (atomic and possibly speculative on the part of Boeing engineers, though it's likely that they received guidance about the size and weight of atomic bombs of probable interest to the Army Air Forces, such as the Mark III 'Fat Man') of 61in diameter and 150in length was also considered.

The mighty 44,000lb T-12 'Cloudmaker' bomb, an enlarged version of the 22,000lb 'Grand Slam' developed by the British during the war, would have largely filled the bomb bay. As with the Grand Slam, the Cloudmaker was designed to penetrate deep underground before detonation, using a thick steel case to penetrate dirt and concrete before detonation. The B-36 bomber was the only aircraft that could actually carry the T-12; none were used in action as the bomb was not available until 1948. But in 1946, the ability to carry such a massive bomb indicated not only that specific capability, but the capability to haul other as-yet undeveloped massive weapons… such as the new atomic bombs that were being designed and developed just as fast as the early American atomic industry could manage.

General Laurence C Craigie, chief of the Engineering Division at Wright Field, recommended on May 23, 1946, that the Army Air Forces accept the Model 462 for a Phase I development contract. The following month, the Air Materiel Command at Wright Field informed Boeing that they had won the competition and on June 15 the new aircraft was officially designated XB-52. A letter contract for Project MX-839 (the XB-52) was approved on June 28, awarding Boeing the Phase I effort to create detailed designs, wind tunnel models and tests and a full-scale mockup.

What should have been a time of exultation for those working on the XB-52 was promptly rained on, as the design was massive yet failed to meet the range requirement. This opened it up to attack by those in the Army Air Forces who didn't care for it, attacks that would go on for several more years and would threaten the whole project with cancellation.

Boeing Model 462-5

Model 462 was a very large aircraft, with a span only 9ft shorter than that of the B-36, and a length only a foot shorter. Empty weight was lower than that of the B-36, but gross weight was substantially greater.

While most performance requirements were met, armament weight and turboprop inefficiencies meant that the operating radius fell short at only 3,570 statute miles (3,100 nautical miles). Some thought was given to increasing gross takeoff weight to 480,000lb by adding droppable external fuel tanks; this would have required rocket assist for takeoff.

The Model 462 design continued to evolve through multiple iterations; Model 462-5 from September 1946 moved the turboprops from below the wing to above.

Boeing Model 462-5

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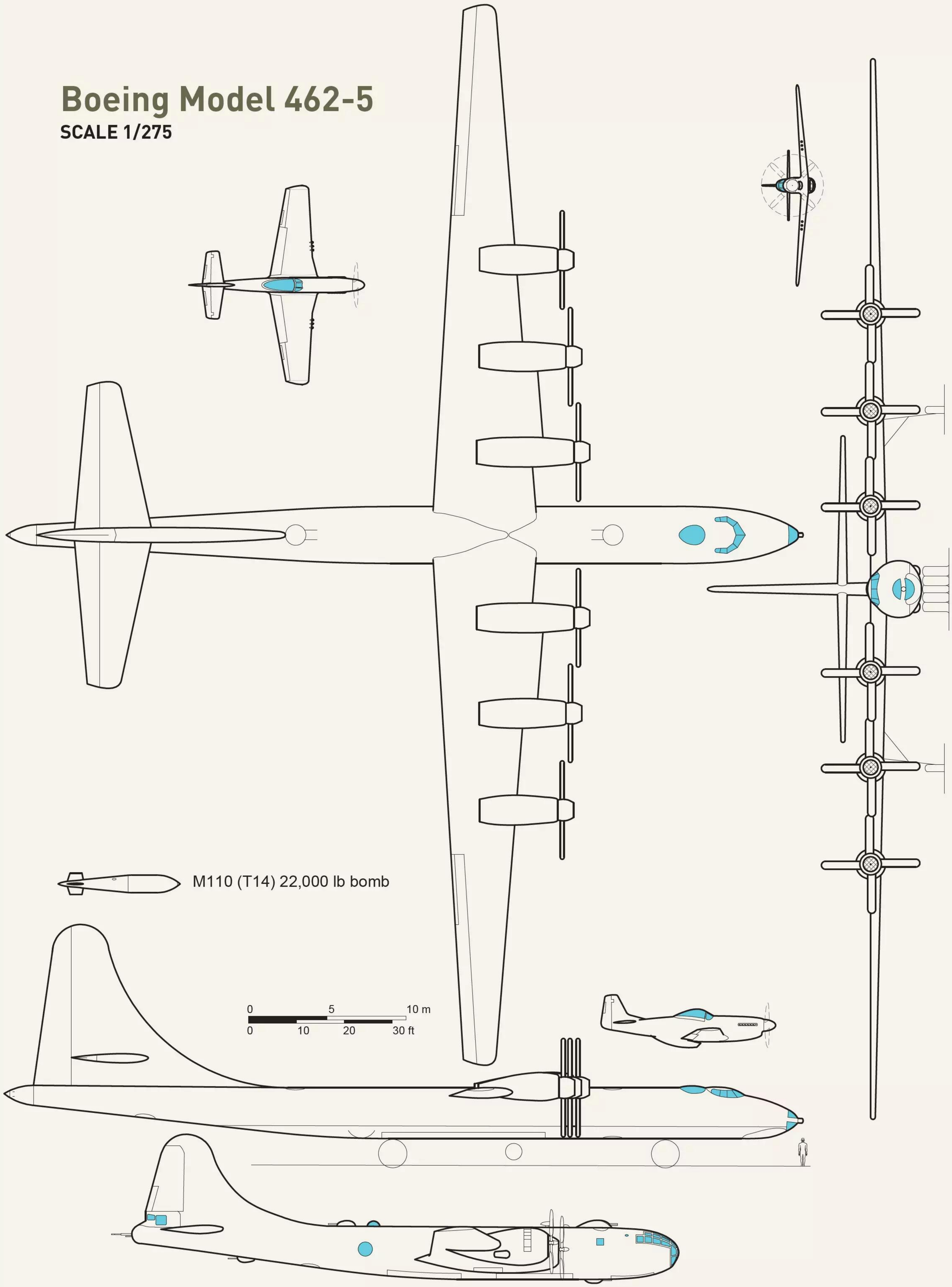

Boeing Model 464-17

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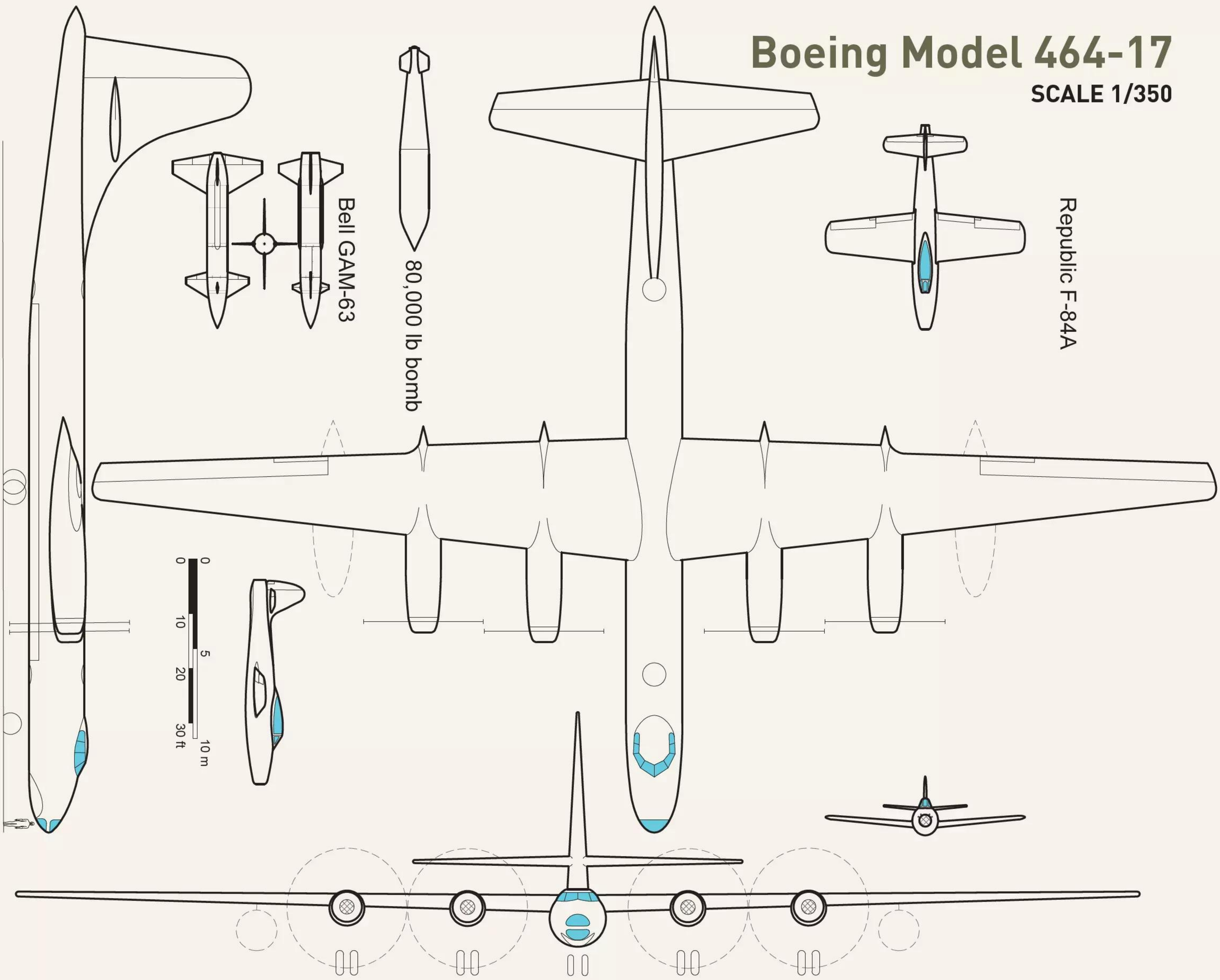

Boeing Model 464-18

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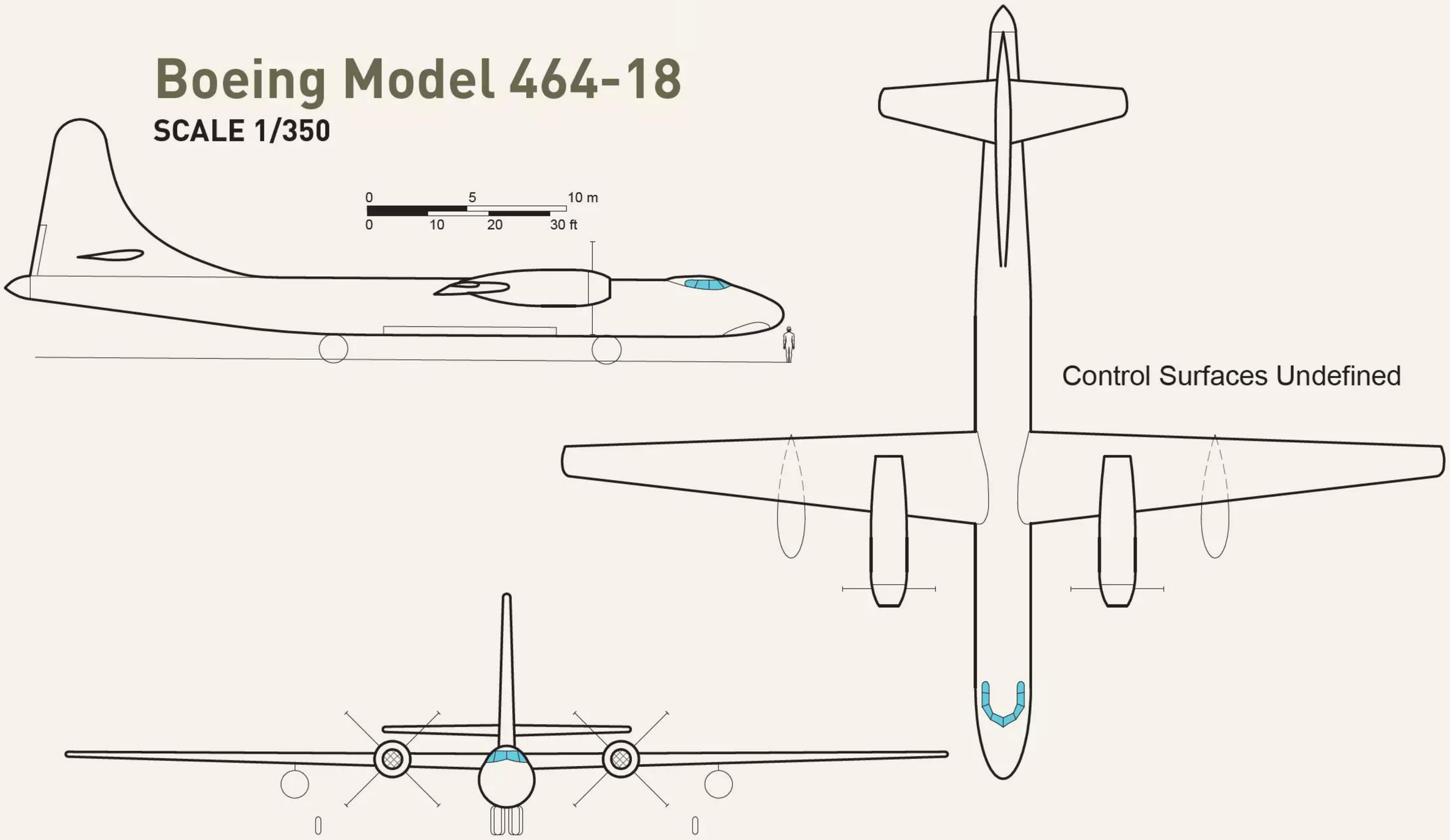

Importantly, the main landing gear was moved from the engine nacelles to the fuselage and smaller outrigger stabilizer landing gear were added – forming the arrangement that would eventually be used on the B-52. Putting the landing gear in the fuselage meant widening it and saying goodbye to a purely circular cross-section. Unconventionally, 'blisters' that form-fitted the outboard wheels were added, since even with a wider fuselage the wheels just didn't fit. Despite all the tinkering, though, Model 462 was simply not going to meet range requirements.

By October, complaints about Model 462's performance shortfall had prompted Boeing to greatly modify the original concept, resulting in Model 464. This was generally similar to the Model 462 but smaller, lighter and with only four engines. A number of early 464 variants were studied and within a few months Boeing had one that fit the bill.

Boeing Model 464-16 and 464-17

Boeing unveiled Models 464-16 and 464-17 in December 1946. Boeing's redesign efforts had been aided by new data from Wright Aeronautical on an improved T-35-5 turboprop. With greater power (8,900hp) and better specific fuel consumption, Model 464 was able to fill the mission requirements with only four engines. Range was at last where it was supposed to be.

Model 464 had a conventional configuration, with long straight shoulder-mounted wings and a tail much like that of Model 462. The turboprops were mounted to the leading edges (with the bulk of the nacelles below the wings), each powering 22ft-diameter counter-rotating propellers.

Models 464-16 and 464-17 were externally largely identical but their interiors were quite different. The -16 was specifically designed as an atomic bomber, with a 15ft long bomb bay just large enough to carry a single 'special' weapon. Model 462's retractable turrets were completely deleted, the vacated space now filled with fuel cells, bringing total capacity to 36,500 gallons and giving a range more than adequate to meet requirements. In effect, it was a flying fuel tank wrapped around a single atom bomb, dependent wholly on speed, altitude and luck to avoid enemy interception. Model 464-17 kept the turrets and a 65-foot-long bomb bay, making it a general purpose bomber capable of carrying a Cloudmaker or a factory's worth of smaller bombs… diagrams also depict it carrying a single 80,000 pound bomb. Fuel capacity was 20,200 gallons, substantially less than that of 464-16; the fuselage was slightly larger in diameter than the 464-16's, 130in vs 126in. The Army Air Forces preferred Model 464-17 to Model 464-16 due to its greater flexibility.

At 400,000lb takeoff weight, Model 464-17 could carry 10,000lb of bombs on a mission radius of 3,800 nautical miles. This was still short of the hoped-for 4,350 nautical mile radius. However, adding drop tanks and increasing takeoff weight to 480,000lb gave a 5,000 nautical mile radius. Model 464-17 could carry 90,000lb of bombs with a mission radius of 1,950 miles. Maximum speed at 35,000ft would be 382 knots. The Air Force requested in April 1947 that Boeing examine the XB-52 as a GAM-63 RASCAL missile carrier. Boeing found that, with some modifications to the RASCAL, one could just barely be carried internally, though it would likely be easier to carry two externally – most likely on pylons either between the inboard engines nacelles and the fuselage or between the inboard and intermediate nacelles. No diagrams of these layouts have been found by this author, however.

Defensive armament consisted of four body-mounted retractable turrets and one tail turret, with a total of 12 x 20mm cannon, much as with the Model 462. Studies also looked at the use of manned wingtip gun turrets. A Phase II proposal was issued for Model 464-17 in January 1947.

Boeing Model 464-18

A smaller version of 464-17 with just two turboprops was drawn up in mid-late 1946 as Model 464-18. Bomb load was reduced from a maximum of 90,000lb to just 10,000lb. Range, thanks to the addition of large underwing drop-tanks, was only slightly decreased compared to the -17. Armament was four 20mm cannon. Distribution of the guns is unclear, but it is probable that two of them were in a tail turret. Little data is available on this design and since it went the wrong way with regards to range, it was probably a rather academic exercise and went nowhere.

Boeing Model 464-25

Offering slight improvement on 464-17 was Model 464-25 of July 1947. The wings got a leading edge sweepback of about 14°, the props got different spinners, the nose was slightly recontoured with a flush-topped cockpit and defensive armament was cut to a tail turret plus two retractable turrets (one above the forward fuselage, one below), all three armed with 0.50cal machine guns. Perhaps the biggest step towards the B-52 from the -17 to the -25 was the change in landing gear: -25 had four main wheels within the fuselage, with small outriggers located in the outboard engine nacelles.

Fuselage fuel load was reduced slightly (7,700 gallons from 9,460 gallons), but wing fuel tankage was greatly increased (19,200 gallons from 10,740 gallons). Additionally, external fuel capacity was increased from 19,200lb to 68,700lb. With a decrease in bomb load from 90,000lb to 12,000lb, suiting a single Mark III 'Fat Man' atomic bomb (drawn as such in the original Boeing diagram), this brought gross weight to 400,000lb.

Boeing Model 464-25

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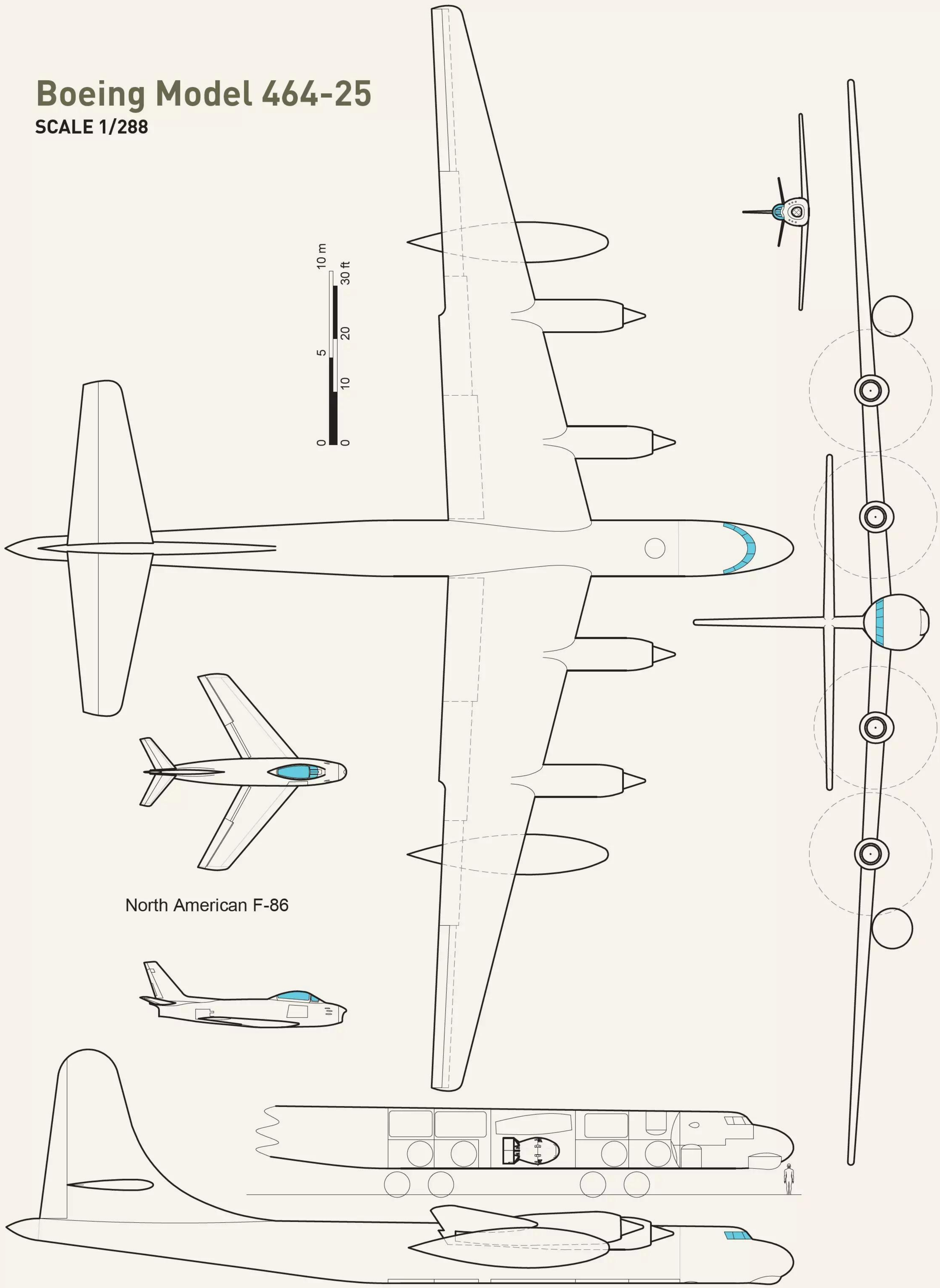

Boeing Model 464-27

This short-lived continuation of the B-52 design evolution, designed on October 20, 1947, followed on from Model 464-25. It featured wings swept back slightly more, a refined fuselage and a return to the raised cockpit canopy. The tail surfaces were substantially changed too but the basic data for the Model 464-27 was not much different from that of the 464-25. Model 464-29 was also produced at this time and differed from 464-27 mainly in being 17in longer and in having a vertical stabilizer trailing edge that was straight up and down rather than slightly aft-swept.

Dark clouds formed on the horizon in November 1947. The baseline Model 464-17, at nearly 500,000lb gross takeoff weight, was seen as too slow and heavy by many in the Air Force. It was also too expensive to procure in useful numbers. All staff present at a conference in the office of the Director of Research and Development in Washington, D.C. agreed that the 464-17 should be cancelled.

Turbojet development had reached a point where some believed the mission required a pure jet-bomber, not one powered by turboprops. But should Boeing be ordered to redesign the XB-52 or should the whole contract be scrapped and a new competition started? In mid-December, the Director of Chief of Staff/Materiel ordered the Air Materiel Command to cancel the contract and share the following characteristics among the American aviation industry for re-bid: 500mph+ top speed at tactical altitude, 500mph average speed, 35,000ft tactical operating altitude, 8,000 statute mile range at design weight conditions, 9,000ft takeoff distance over 50ft obstacle with RATO, 9,000ft landing distance over 50ft obstacle without droppable fuel and bombs, and a 10,000lb average bomb load.

At the same time, in flight refuelling was becoming a reality. Postwar experiments using a trailing hose snagged by the plane attempting to refuel had been successful, though the process was clunky and fuel flow rate was poor. Boeing, however, was developing the 'flying boom' system, which put most of the work into the hands of an operator in the tanker aircraft; tests with modified B-29 aircraft had been successfully carried out in September 1948, and promised a practical means of greatly extending the range and duration of the XB-52.

Boeing and its allies in the Air Force defended their efforts all through December 1948 while others argued to cancel the contract. But finally, at the end of December the Air Force was authorized by the Air Materiel Command to keep going with the Boeing programme. The atom bomb itself was also in flux as the Mark III design was due for replacement by the Mark IV with improved aerodynamics; the 'Fat Man' configuration had proven to be erratic, missing the target by more than 2,000ft during the Able shot of the Crossroads operation at Bikini Atoll on July 1, 1946. The Mark IV configuration was due in early 1948.

Boeing Model 464-33-0

Designed in January 1948, Model 464-33-0 was a refinement of the earlier Model 464-27. Some changes were subtle – the wings had slight anhedral rather than dihedral, the wing sweep was increased, and the tail surfaces were distinctly aft-swept and more modern in appearance. However, while the designs looked similar, the -33 was a substantially smaller vehicle than the -27 and had a much lower gross weight. This was possible largely thanks to the incorporation of inflight refuelling into the design. Fuel could be loaded through a flying boom at a rate of 400 gallons per minute. Wingspan dropped from 205ft to 185ft – the span the eventual B-52 would have. Gross weight dropped from more than 400,000lb to a much more manageable 260,000lb.

As with the -27, the undercarriage was 'bicycle' main gear and smaller stabilizing outriggers deploying from the outboard turboprop nacelles.

Boeing Model 464-34-3

A minor modification of the 464-33, this design primarily involved a change in cockpit layout, though it also had a substantial increase in gross takeoff weight. The wide, dome-like cockpit of the earlier vehicle – somewhat like that of the B-36 – was replaced with a long slim tandem cockpit of the kind used on the Boeing B-47. In some ways, the Model 464-34 was the first of the design series that began to look like the actual XB-52.

Boeing Model 464-35

Model 464-35 of January 1948 was a major design iteration and was, for a time, looking like it would either be the XB-52 as built or the last design before cancellation. Just after it had survived a cancellation attempt by some in the Air Force, Boeing's project faced a new threat from Secretary of the Air Force Stuart Symington, who wanted to cancel it in favour of Northrop's YB-49 Flying Wing. This is somewhat ironic, given Symington's stormy relationship with Northrop. As it turned out, the Flying Wing had serious stability issues and ended up crashing during a test flight in June 1948. Once that happened the Flying Wing programme, already troubled, was doomed; it never again threatened the B-52.

Wind tunnel testing had produced an important change in wing geometry. The wing had a root thickness of 16%, but it tapered down to 10% at the tip. The thicker wing root did not appreciably affect drag characteristics but did improve overall structural efficiency. The thin, high-speed wings designed for the early Model 464 and B-47 aircraft had to be heavily reinforced internally since they

Boeing Model 464-27

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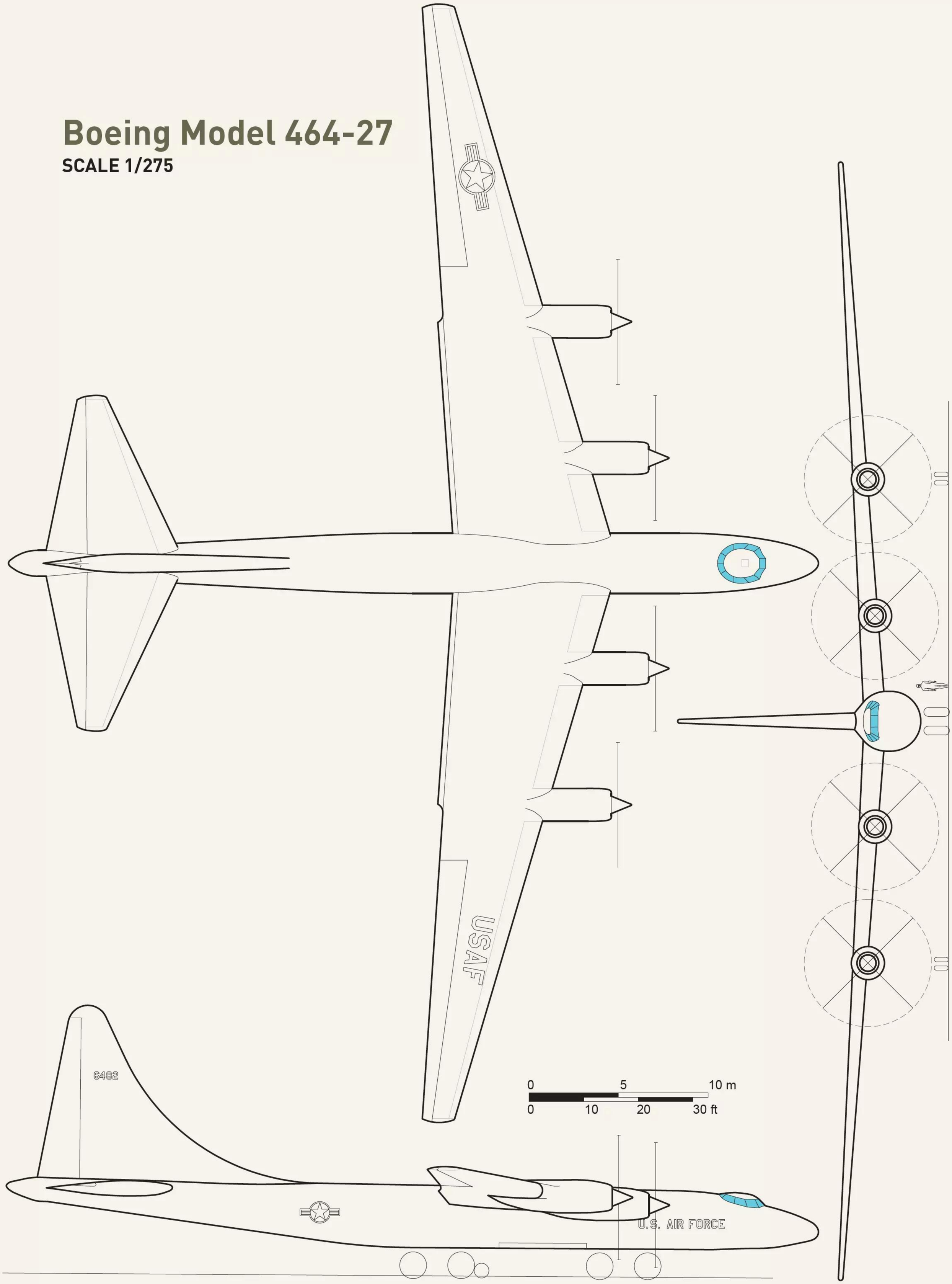
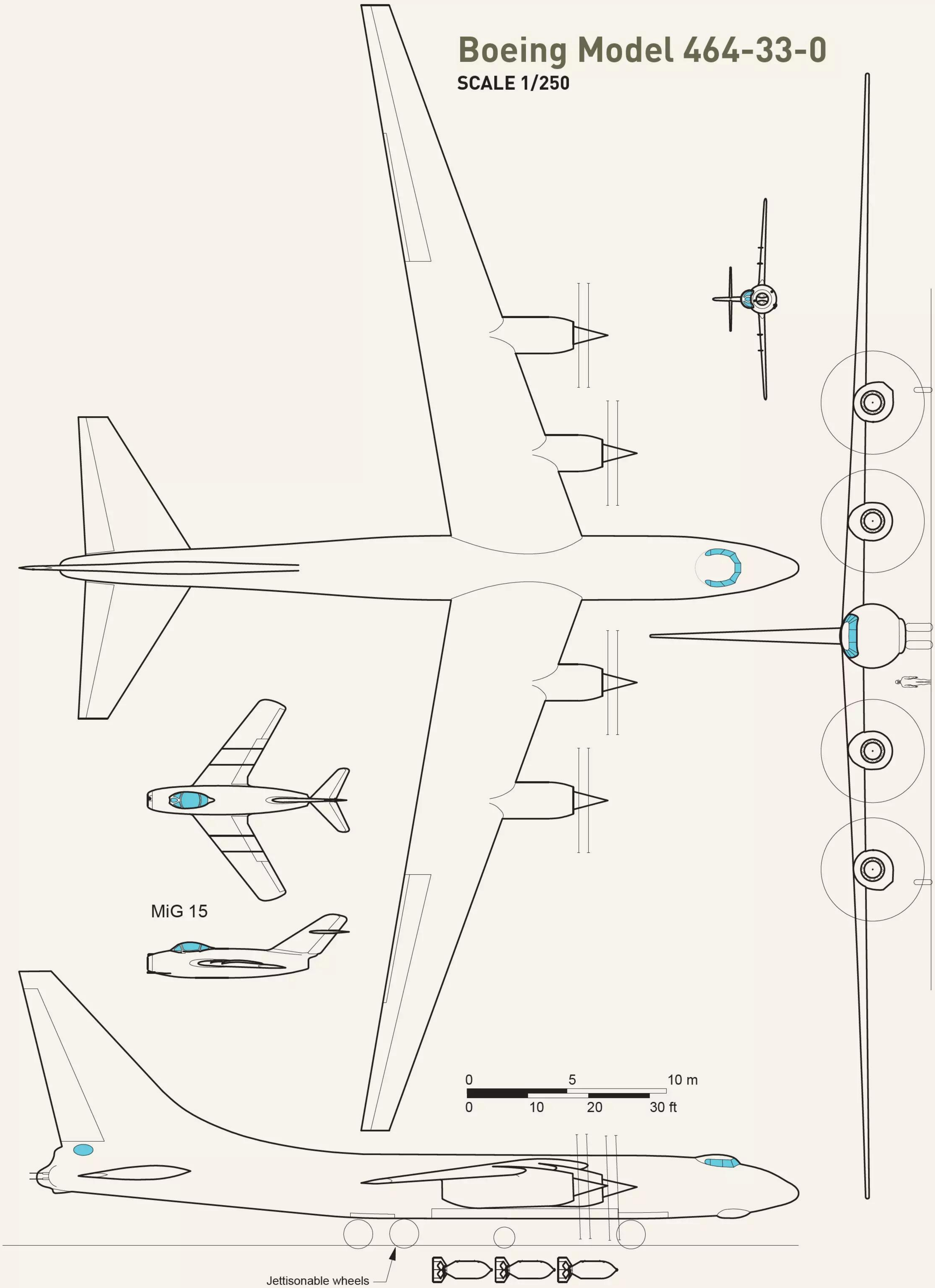


Boeing Model 464-33-0

SCALE 1/250



Boeing Model 464-34-3

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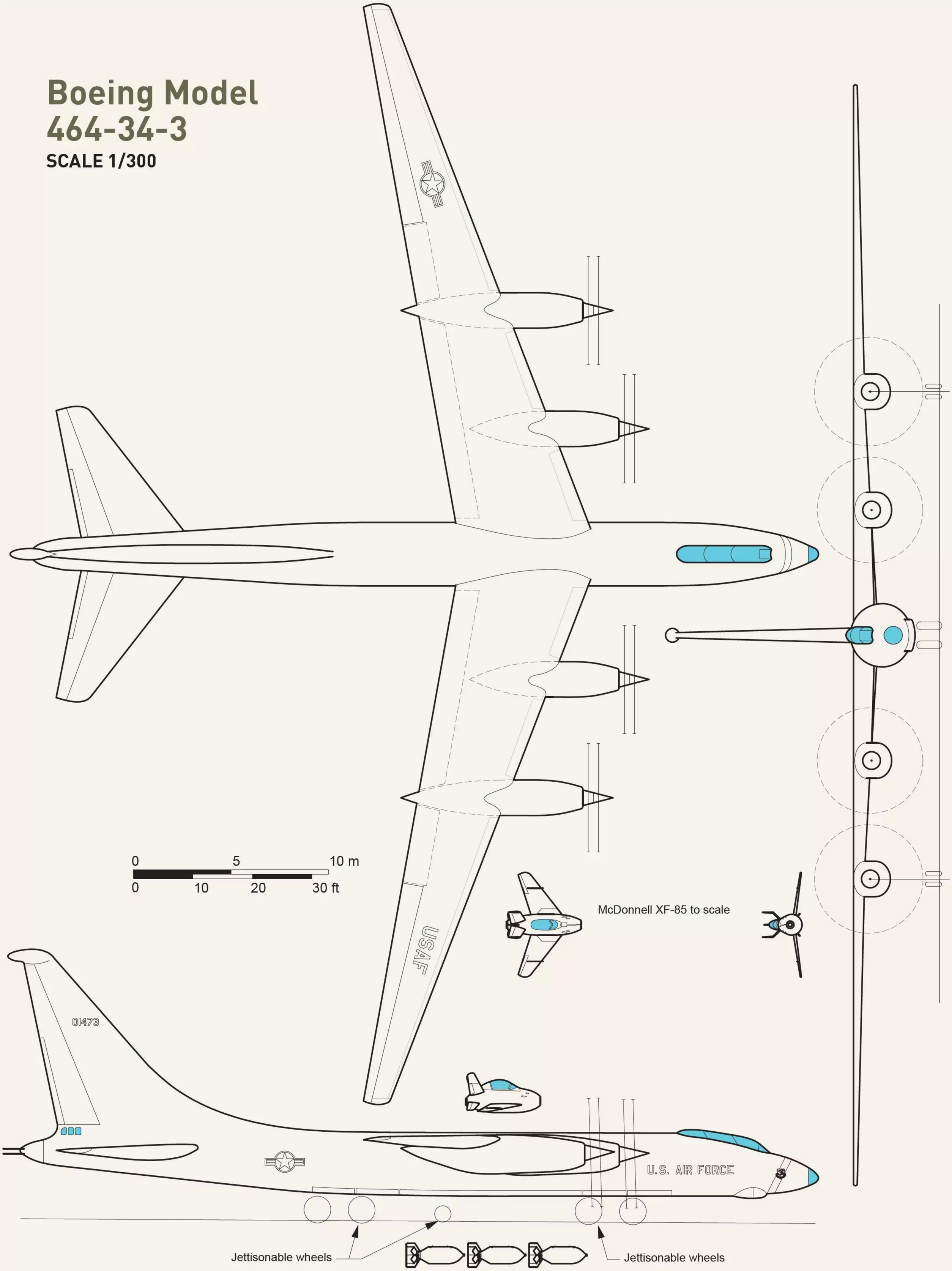
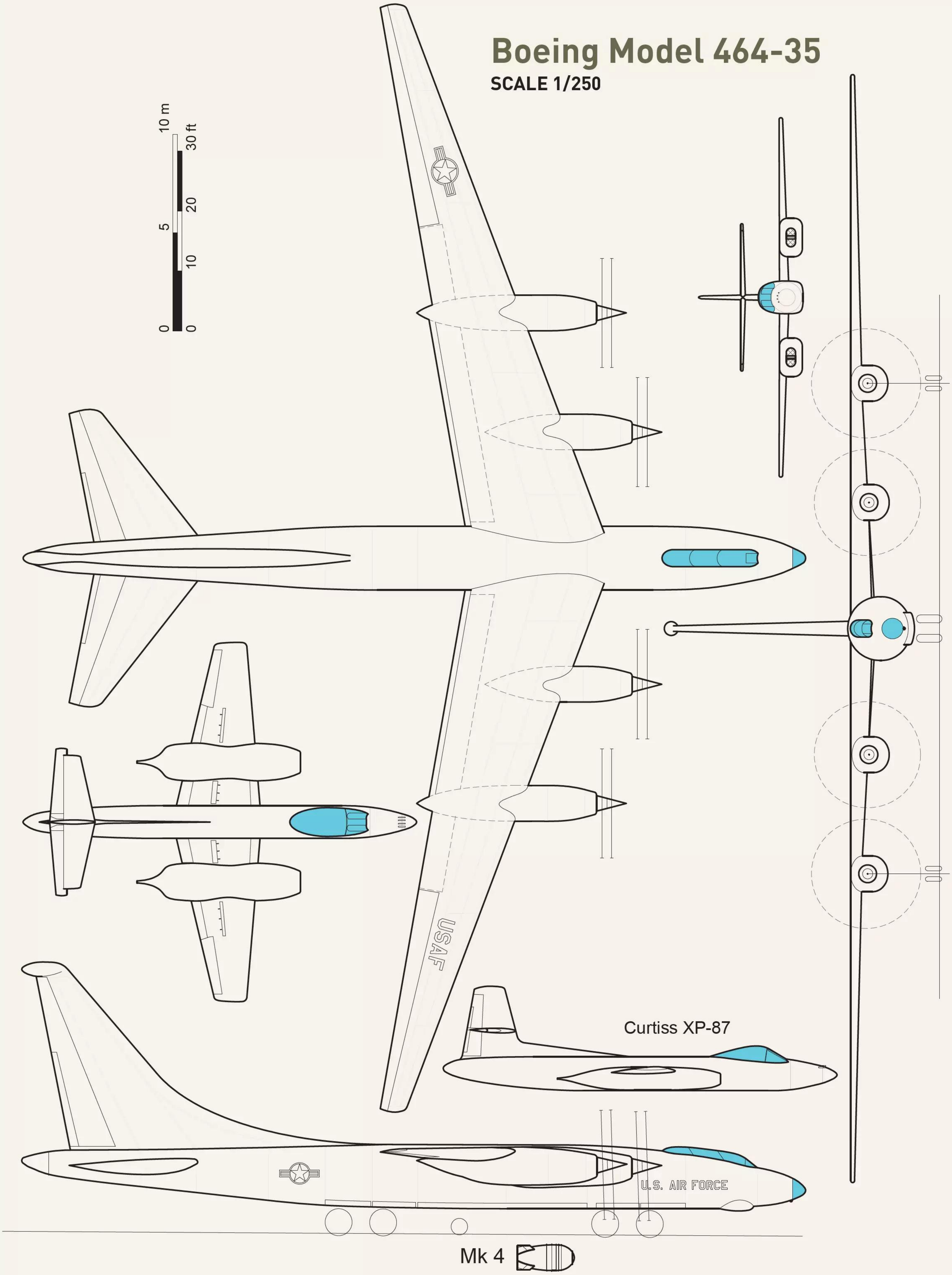


Boeing Model 464-35

SCALE 1/250



were so thin; this made them heavy and precluded the use of wing tanks. Thick wing roots were more spacious and could be used for extra fuel storage.

Model 464-35 had a tail turret for defence, but sources vary on whether it would be crewed or remote-controlled. The diagram included here depicts what seems to be the main line of thinking, that the tail gun would be controlled remotely. While the payload was relatively low at 15,000lb, it retained a long bomb bay capable of carrying a physically bulky payload. By this point, though, the idea of dropping giant conventional bombs had become almost passe; atomic weapons were what a long-range bomber would carry. Still, the larger bay gave options.

The Strategic Air Command weighed in on the B-52's cockpit layout during February 1948, based in large part on a series of mockups built for the Model 464-17. A tandem arrangement was preferred; a cockpit like that of the B-47 made ejection seats easier to accommodate and produced lower drag than a side by side cockpit. Also in February, the Air Force definitively decided against reopening the competition; at last Boeing could rest easy in the knowledge that its long-range heavy bomber would not be taken away. The contract between Boeing and the Air Force was amended in March to make Model 464-35 the baseline.

Discussions between engine and propeller manufacturers in May 1948 indicated that it could take as long as four years to perfect the turboprop propulsion system required for Model 464-35. Additionally, the Air Force personnel involved evidently just didn't like propellers, preferring jets instead. Given that the late 1940s was entering firmly into the Jet Age, with jet fighters well along the path of replacing prop fighters, and the B-47 jet bomber in flight testing, this preference was becoming less a matter of taste and more a matter of simple practicality. Boeing certainly took note of this, and while retaining the baseline 464-35 for the time being, produced another design.

Boeing Model 464-40

The Model 464-40 preliminary design drafted in April 1948 was submitted by Boeing in July 1948, following a USAF request the previous month. Its airframe and equipment were essentially those of Model 464-35 but with eight Westinghouse XJ40-WE-6 turbojets. The engines were in pairs, with nacelles similar to those of the B-47 and with B-47-like pylons holding them below and ahead of the wing leading edges.

This at last cemented the basic configuration of what would become the B-52. The design was not carried out with much detail and was not considered entirely ready for further development, but it was an important step in determining the usefulness of jets for strategic bomber missions. The aircraft was substantially faster than the turboprop version but had notably shorter range. Still, it was considered adequate, especially in light of mid-air refuelling. Studies indicated that if the aircraft had multiple external fuel tanks spaced correctly under the wings, it could be refuelled in flight to a weight of 450,000lb without greatly increasing the empty weight. This would give the Model 464-40 a range of around 9,000 nautical miles.

The design was seemingly intended to be built not as a production aircraft but as a modified version of the Model 464-35 XB-52; a XB-52 turboprop airframe would be either rebuilt with jet engines or taken from the assembly line and completed with jets. The available diagram of Model 464-40 is subtly different from the 464-35 in a number of areas, however. As interesting as the Model 464-40 was, though, 464-35 continued to remain the baseline.

Boeing Model 464-41

Designed in April 1948, 464-41 returned to the all-turboprop configuration from the all-jet 464-40. Little information is available it, but even though it didn't have the final B-52's engine arrangements it did have a fuselage much more like that of the final XB-52. Rather than being circular in cross-section it was slab-sided, with rounded corners. The wing had a lower sweep than that of the B-52, but the cockpit canopy was refined from prior designs and somewhat resembled the canopy that would be used on the first two prototype B-52s. The tail extended quite a bit beyond the stabilizers and was fitted with ventral and dorsal sighting bubbles for the gunner.

Boeing Models 464-46 and 464-47

A brief and minor pair of designs from sometime around September 1948, Models 464-46 and 464-47 were similar to the earlier Model 464-40 but with six rather than eight turbojets and with the 464-41 fuselage and stabilizers. While 464-46 and 464-47 had the same number of engines as the B-47 and put them into two pods of two jets and two pods of one like the B-47, the 464–46 and 464-47 swapped the inboard and outboard engine pods. The inboard pod had one engine while the outboard pod had the pair. Why it was done this way is unknown, though likely for structural reasons. Model 464-46 had six Westinghouse XJ40-10 engines while 464-47 had six Pratt & Whitney XJ-57 engines… the type that would go on to power the B-52. Performance data is unavailable for either design.

Boeing 'Hotel' design

One configuration iteration has gained a measure of fame as the 'hotel' design. A Boeing team arrived at Wright Field on October 21, 1948, to discuss the B-52 (specifically Model 464-35) with Air Force officials. At this time, the turboprop Model 464-35 design was still

Boeing Model 464-40

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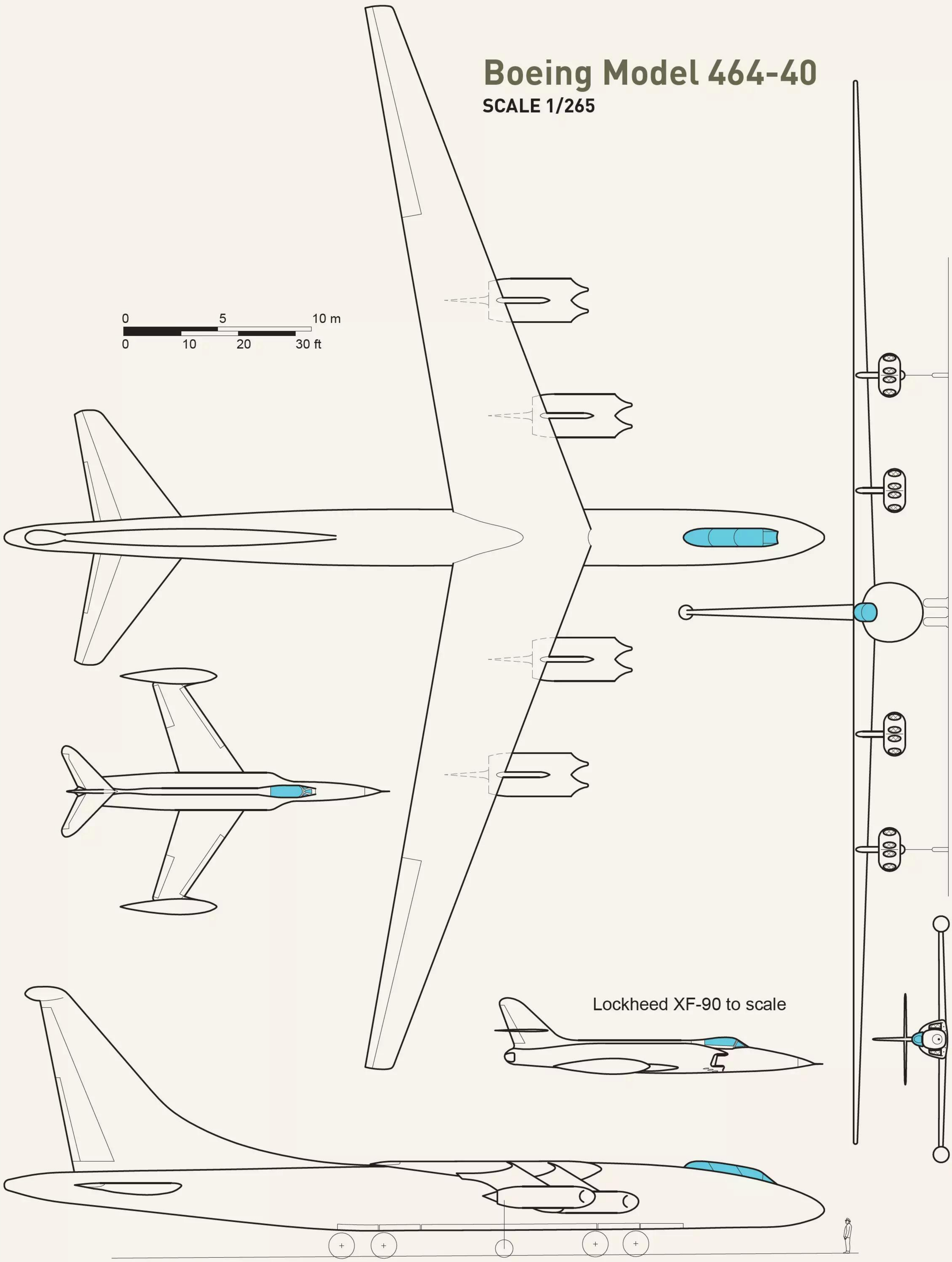

Boeing Model 464-41

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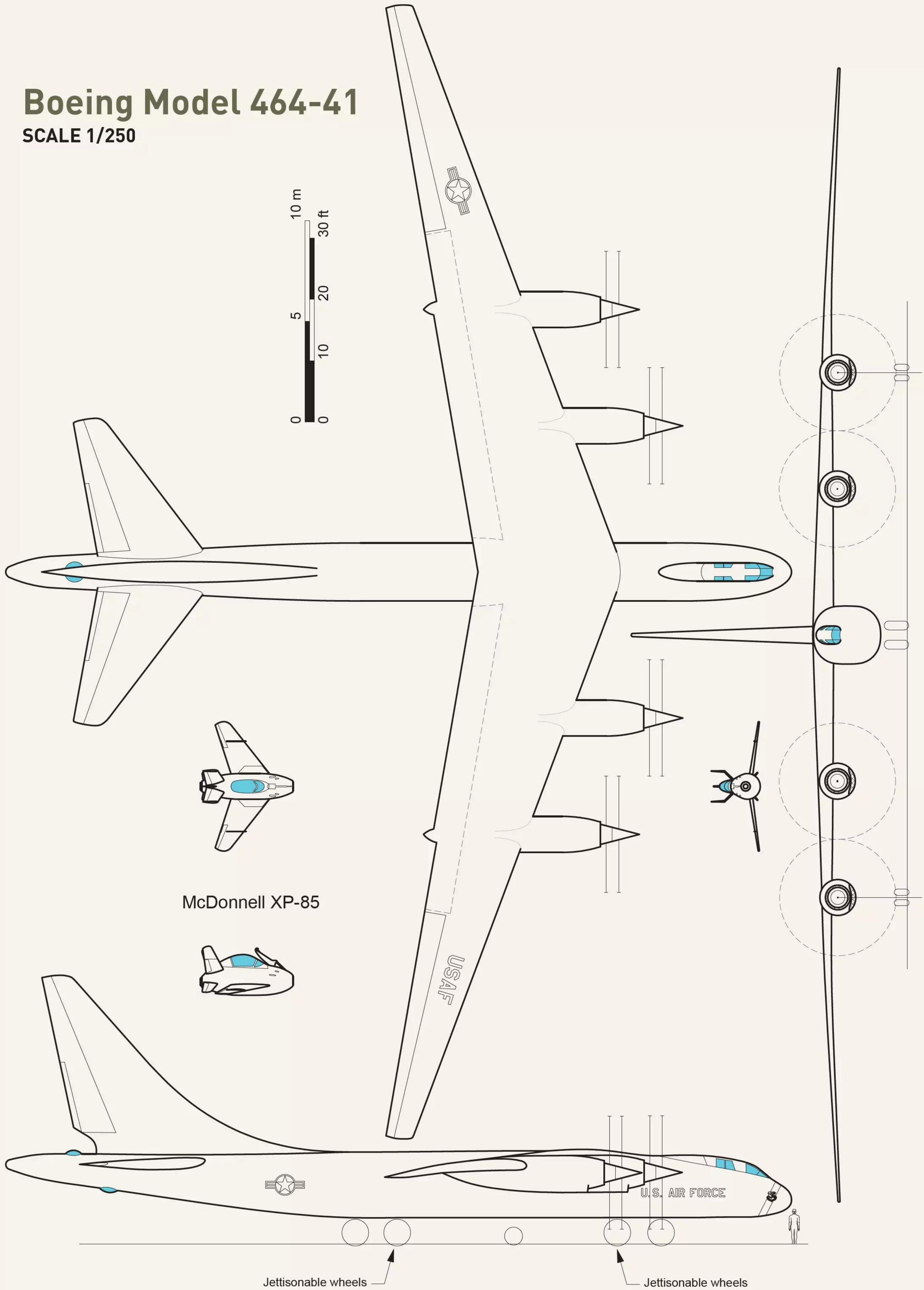
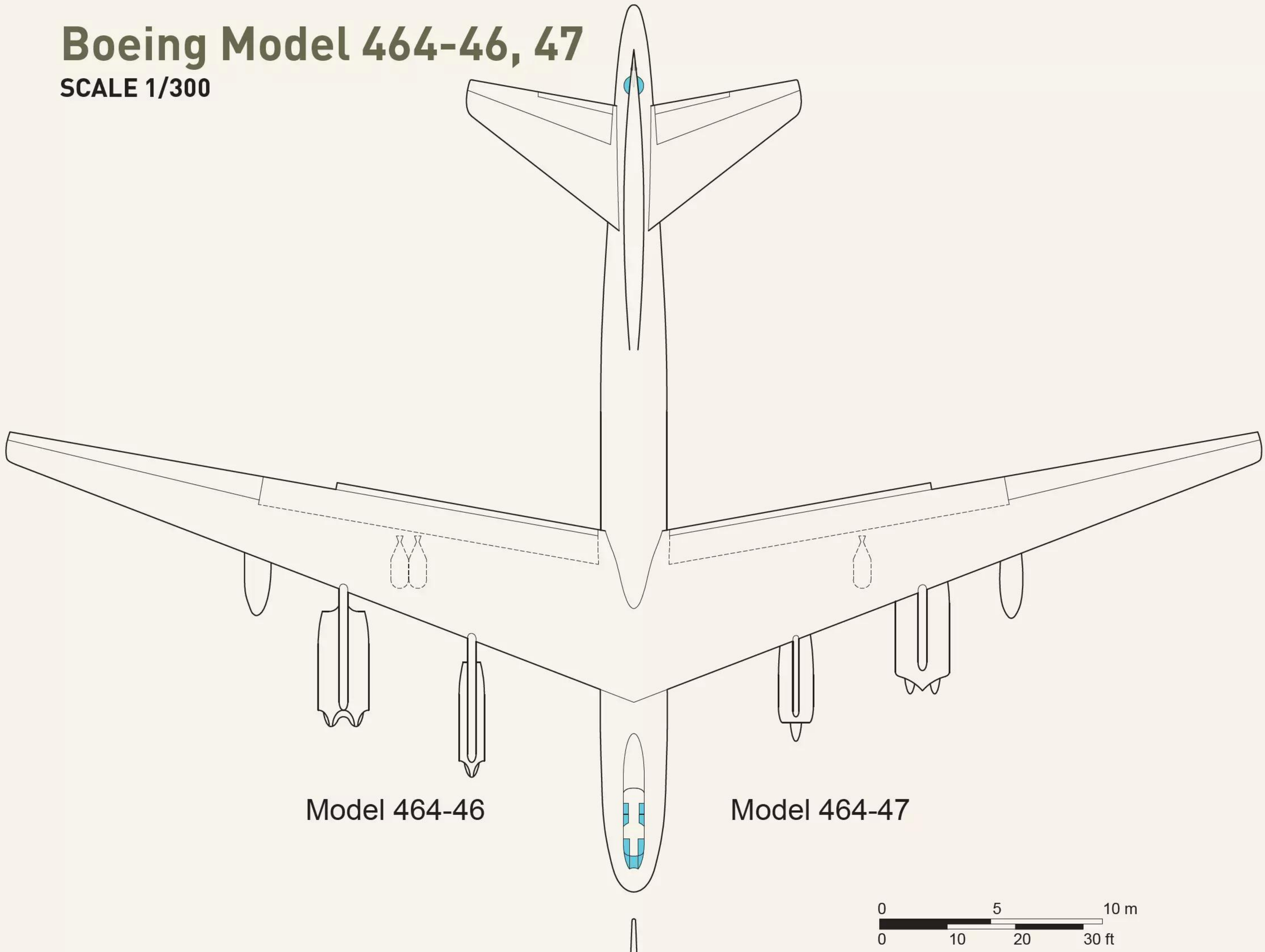
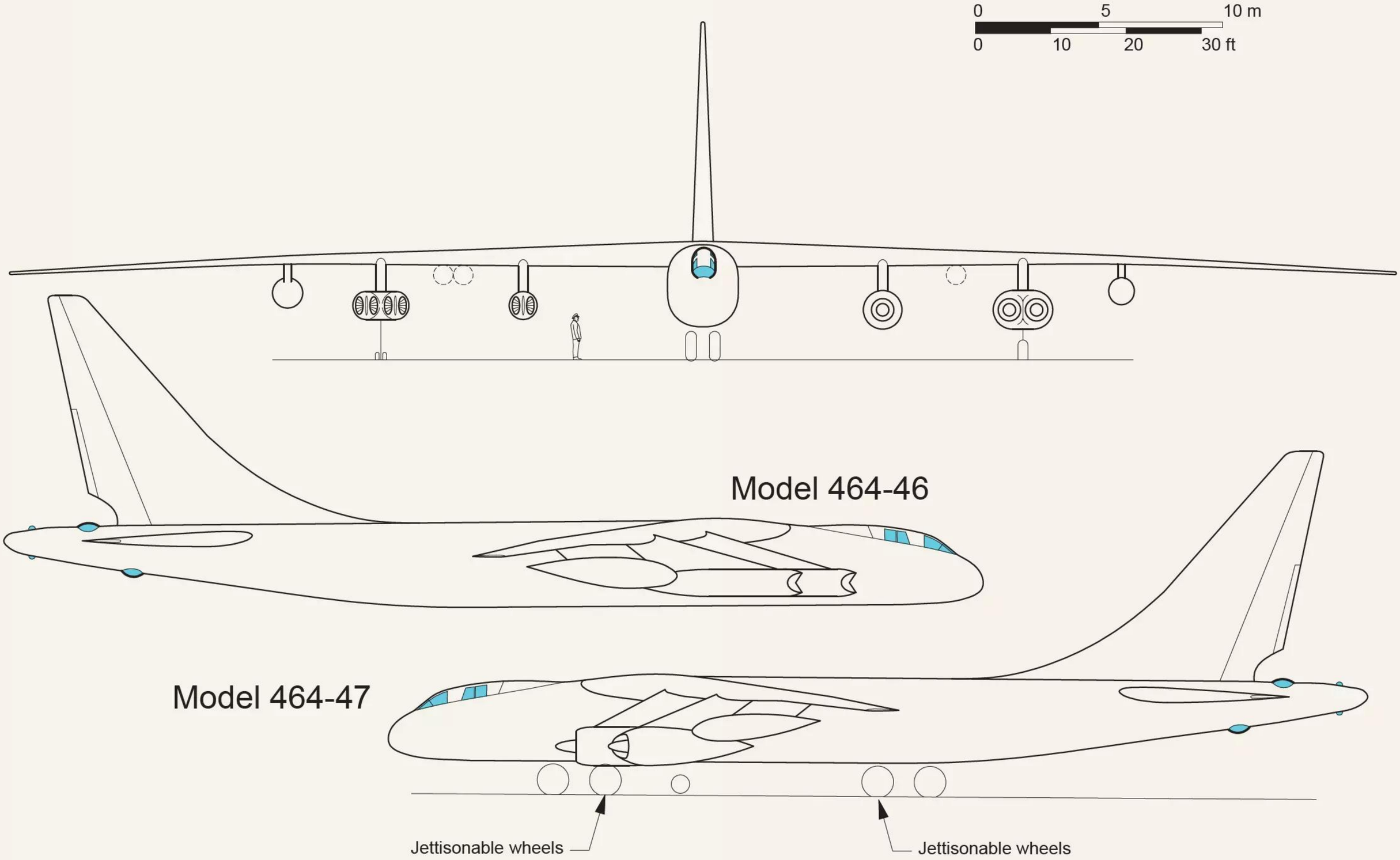


Boeing Model 464-46, 47

SCALE 1/300





the baseline. During the ensuing meeting, the Boeing team were asked to redesign the B-52, taking the latest advances in aerodynamics and propulsion into account. Turboprops weren't working out and flight testing of the B-47 had shown that wing sweep could provide greater aerodynamic benefits than expected.

As the story (simplistically) goes, the Boeing team retired to their motel rooms and over a weekend produced a new, more advanced design. The story usually has it that these Boeing officials whipped up a whole new airplane over a busy weekend, producing a 33-page proposal with a general arrangement, inboard profile and carved balsa wood display model basically from thin air and determination. But there had already been numerous designs produced since 464–35, so the hotel-bound Boeing designers had plenty to work from.

The resulting 'Hotel' configuration was similar to the previous major design, 464-47, but with many refinements. It had much the same configuration but with increased wing sweepback; as a result of considerable wind tunnel research already performed by Boeing, the 20° 52' leading edge sweepback of the 464-47 was further swept to 35° (at the quarter chord). This was the same angle of sweepback that the B-47 had, providing a direct source for comparison. Wingspan was the same at 185ft, but the wing area was substantially raised by increasing the tip chord. The wings were also given substantial anhedral.

The six engines of the 464-47 were replaced with eight in an arrangement similar to that of 464-40, but the new design used Pratt & Whitney XJ-57 turbojets. It was much like the B-52 as actually built, but understandably rather crude given the rapidity of its off-site genesis. The only major difference in shape between this layout and the actual XB-52 was that the fuselage forward of the wing was about 14ft shorter. In fact, the canopy of the tandem cockpit extended further aft than the leading edge of the wing root. The tail surfaces were much closer to those of the B-52 than to those of Model 464-47. The new configuration was presented on October 25, to considerable approval.

Boeing Model 464-49

The penultimate major design in the B-52's development was Model 464-49, a refinement of the 'Hotel' design. The configuration was quite close, but with the details worked out. Visually there were two clearly changes: the vertical stabilizer finally took on its ultimate form. The designed had featured a vertical stabilizer leading edge that gradually curved into the fuselage since before Model 464. With Model 464-49, though, the leading edge was straight from top to bottom. Secondly, the inboard nacelles were moved markedly outboard from their 'Hotel' design position. The outboard nacelles, however, basically stayed put.

The 464-49 used four pairs of main wheels for the landing gear, with small outrigger stabilizers dropping from the outboard engine nacelles. An important difference from the B-52 was that the second and third mainwheel pairs would be droppable after takeoff in order to reduce weight. The five crew were pilot, co-pilot/engineer, navigator, bombardier and tail gunner. The plane's sole defensive armament was two .50cal machine guns in the tail. Given the high altitude and speed expected of the craft, a tail-on attack was considered the only feasible way for enemy fighters to take it on. Model 464-49 was also capable of inflight refuelling.

464-49 was sufficiently impressive that in January 1949, the USAF cleared Boeing to proceed with the all-jet design over the turboprop 464-35. At the same time, Pratt & Whitney received additional USAF funds to continue work on the XJ57 engine and carry it through to component testing.

The XB-52 actually built was Model 464-67 but though there is a substantial gap in the designation list between 464-49 and 464-67 (Model 464-54 was the Phase II version of 464-49), the differences between the designs appear to have been minor. A mockup review of Model 464-52, then known as the XB-52, was held at Boeing's Seattle facility in April 1949. The -52 design not only evolved, it competed. Several other companies put forward designs to fulfill the long range strategic bombardment role.

The Boeing B-55 diversion

Curiously, one of the companies that worked the hardest to replace the Boeing B-47, and to produce a bomber that would compete against the Boeing B-52, was Boeing itself.

Before the B-47 had even flown, the Bombardment Branch at Wright Field was looking towards a future where the B-47 would be replaced. Given the rapid pace of advancement in both jet propulsion and aerodynamics, it was a reasonable assumption that aircraft then on the drawing board would be obsolete in a handful of years. And the fleet of Boeing B-29s and B-50s then in service was already looking elderly. So in October 1947, the Air Force held a competition to design a replacement for the B-29, B-50 and B-47; requirements included a 2,000 mile radius, a 10,000lb bomb load and a gross weight under 200,000lb. Boeing won the competition with Model 474, officially dubbed XB-55, and received the contract to build it in July 1948.

Boeing Model 474

Model 474 was, more or less, an enlarged B-47. Along with the increase in scale, the turbojets were replaced with four Allison T-40-A2 turboprops. The wings had

Boeing D10,000
B-52 Proposal

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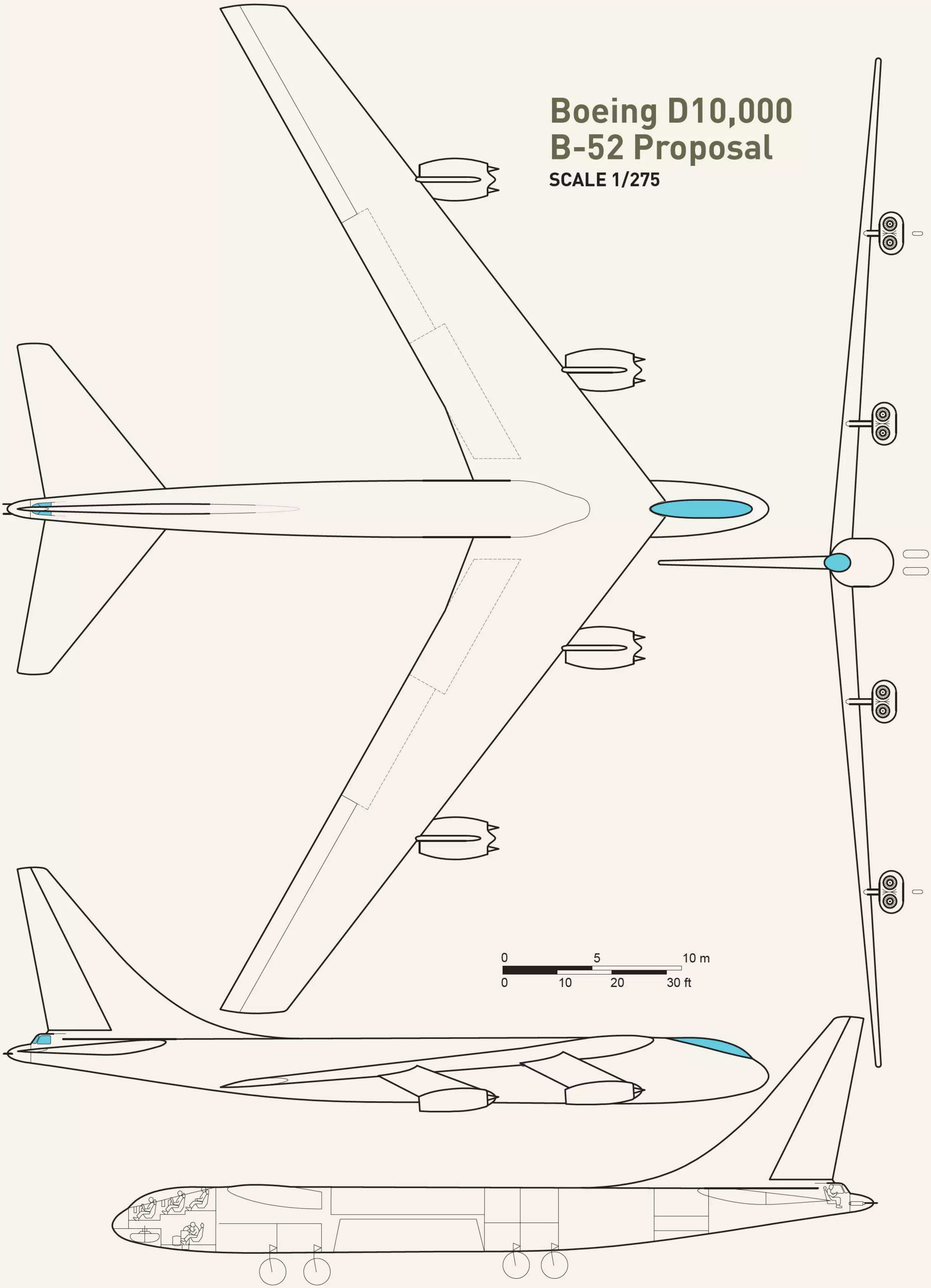

Boeing Model 464-49

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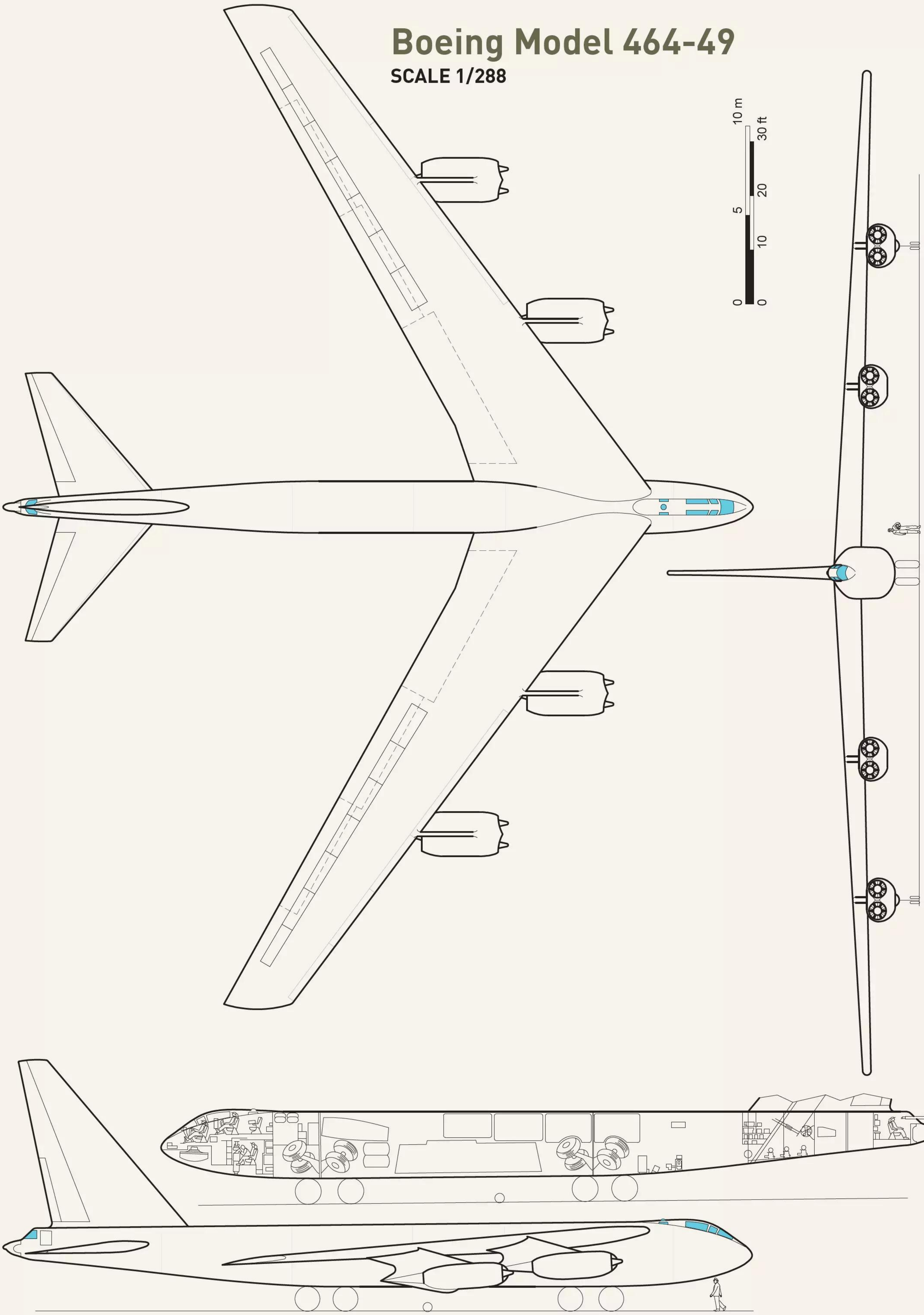
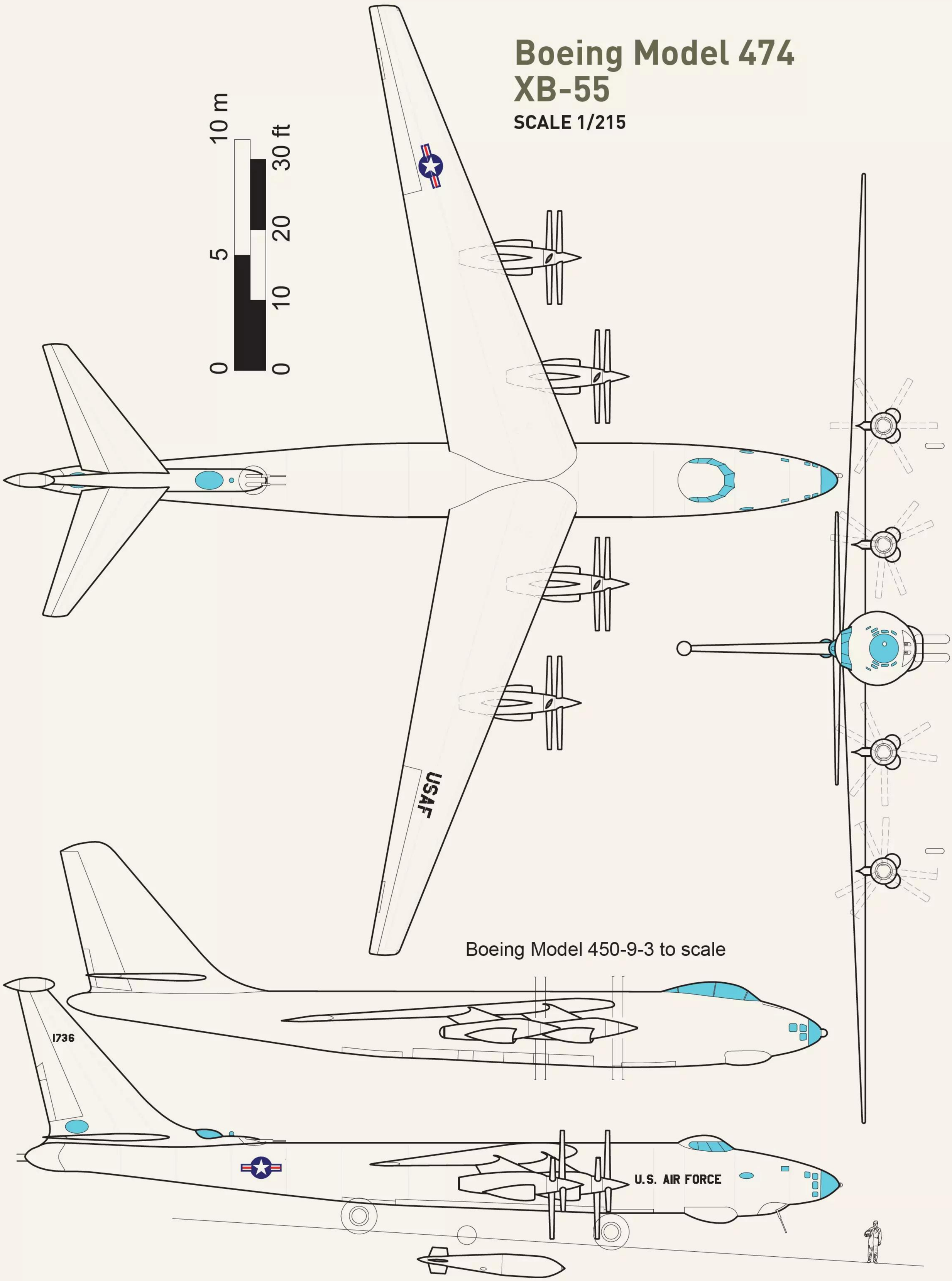


Boeing Model 474
XB-55

SCALE 1/215



reduced sweep at 20°, which makes sense given that the turboprops made the aircraft slower than the B-47. Range, however, was notably greater than that projected for the B-47.

Defensive armament was a little unusual. Along with the expected stinger turret in the tail, there was another blended into the leading edge of the vertical stabilizer root, and a third under the chin. All seemed to be equipped with four 20mm cannon, certainly a potent punch for the time. The tail gun was manned by a gunner who sat at the base of the trailing edge of the vertical stabilizer, looking out through bubble windows on either side; the gunner for the rear fuselage turret had a larger single bubble canopy at the base of the leading edge of the vertical stabilizer. The forward gun was operated by the radio operator or the navigator (it's unclear). Total crew complement was ten.

The T-40-A2 presented some difficulties however. The six-bladed contra-rotating props would need to split the engine's power through a gearbox, and there was some concern that the sheer power of the engine would tear the drive shaft apart. Allison estimated at least three years to get the whole propulsion package running properly. This was a problem.

Boeing Model 479

In January 1948, shortly after Boeing won the competition, but well before being granted the contract to build the XB-55, it produced Model 479. This was the logical next step in the development of the XB-55 and resulted from an Air Force request to examine a turbojet version, bypassing any turboprop-related issues.

It was similar to Model 474, with an engine arrangement just like that of the B-47: two engines in a nacelle below a pylon under the wing, with a single engine attached to the underside of the wing further out. This was the third turboprop-powered Boeing bomber that had made the switch to turbojets while still on the drawing board.

Wingspan was increased by 15ft and area by 1,000sq ft. Defensive armament was reduced to just the tail turret; Model 479 would depend on speed for survival. The nose was shortened substantially. The wing featured different thickness ratios, being thinner at the wingtip, the advantages of which are described in the section on the 464-35. The 'second generation swept wing' as Boeing called it was first introduced here in the Model 479 XB-55. The XB-52 design team would incorporate the feature in Model 464-35 and take full advantage of it in Model 464-49.

The US Air Force cancelled XB-55 development in January 1949. This was partly due to lack of funds in 1949 and partly because LeMay wanted Boeing to concentrate its efforts on the B-52.

Boeing Model 483-11

The XB-55 project had a number of offshoots, unusual designs linked to it in ways that remain somewhat ill-defined. The Model 483 series is included as part of the B-55 design family; whether these were designed that replaced Model 479, or were simply studied alongside it is not currently clear. Only a few examples of Model 483 are known today, and then only via fragments.

Model 483-11 had a layout somewhat similar to the B-47 or the Model 479, but equipped with only four jet engines. Wing sweep was substantially greater than that of Model 479 or even the B-47 at 41.5°. This done to help improve its top speed. While performance data for 483-11 is not available, some is available for Model 483-36. As Models 483-11 and 483-34 are known from layout drawings, have very similar configurations and are almost exactly the same size (the two differ only in the location of the engine nacelles; the -11 has them spaced 50ft apart; the -34, 72ft 4in), it's reasonable to assume that Model 483-36 was also quite similar.

This aircraft was intended to reach Mach 0.95. An aircraft capable of that would probably be able to go supersonic in a dive and stay there after pulling out into level flight. Whether staying supersonic would break things on the aircraft, such as skin panels, compressor blade or wing spars, is another question.

Boeing Model 483 Delta

A very different configuration also lays some claim to the XB-55 mantle… a tailless configuration with near-delta wings. This design is known from a single simple diagram, devoid of any real data except a scale reference. It had four engines, just like the other known Model 483 configurations, contained in two twin-engine nacelles, each pylon suspended under the wings. No other data is known. It is depicted here with a much later A-12 Avenger II to scale; the designs bear some similarity, though the earlier one clearly has a much lower claim to being a stealthy aircraft.

Boeing Model 484-102

The Model 484 designation was something of a catch-all for jet bomber designs. Most Model 484 designs ended up as part of the development of the supersonic MX-1712/MX-1965/XB-59 project, but some were subsonic and related to the extended XB-55 project. A few of these have survived as at least basic three-view diagrams.

Model 484-106 dates from approximately 1948 and was a geometrically straightforward delta wing design. Known solely from a single small set of diagrams, it was fitted with a single large delta vertical fin for stability. Four turbojet engines were buried within the wing, two on either side of the central bomb bay. Each engine had

Boeing Model 479
XB-55

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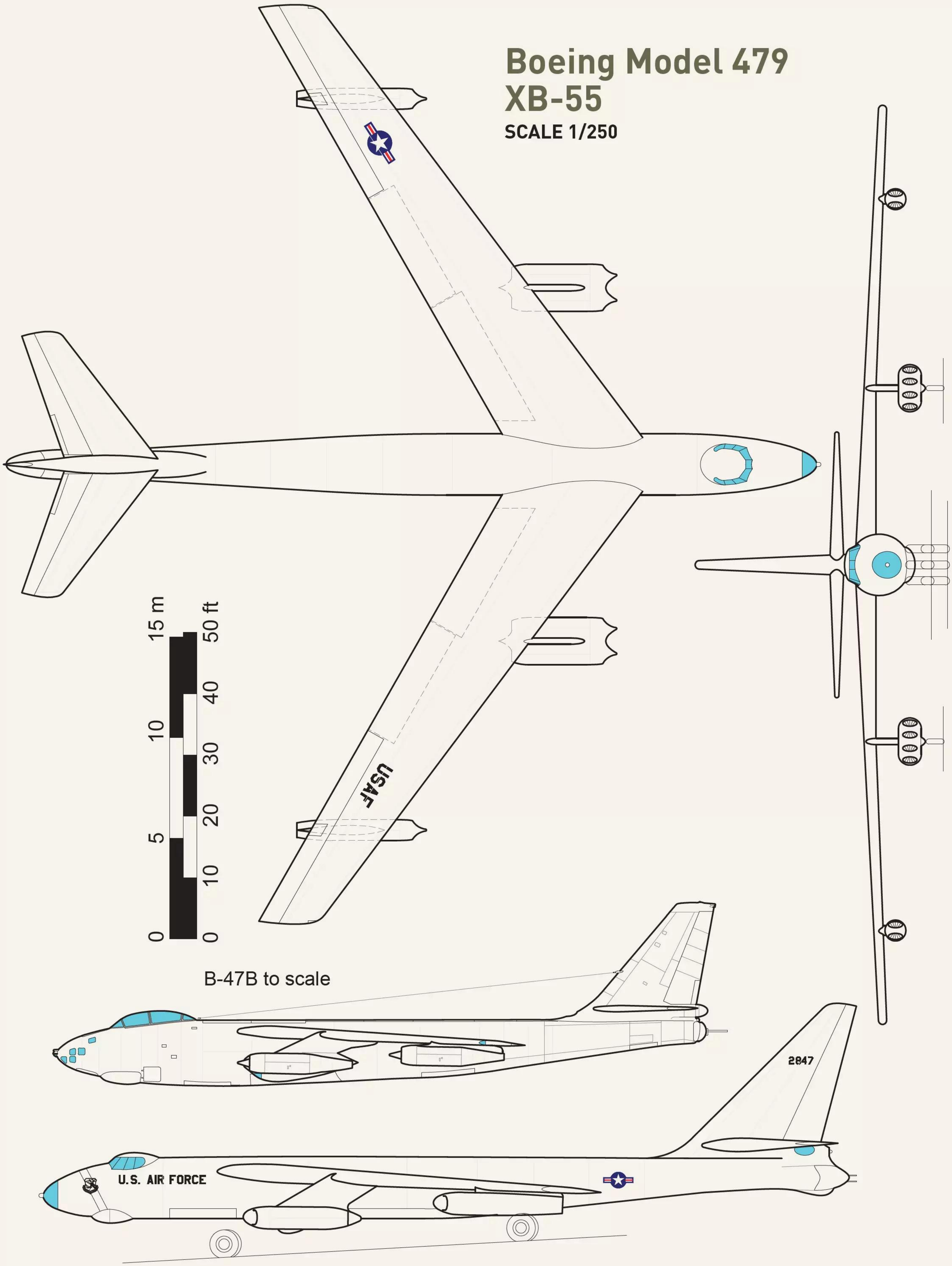

Boeing Model 474 + 479
XB-55

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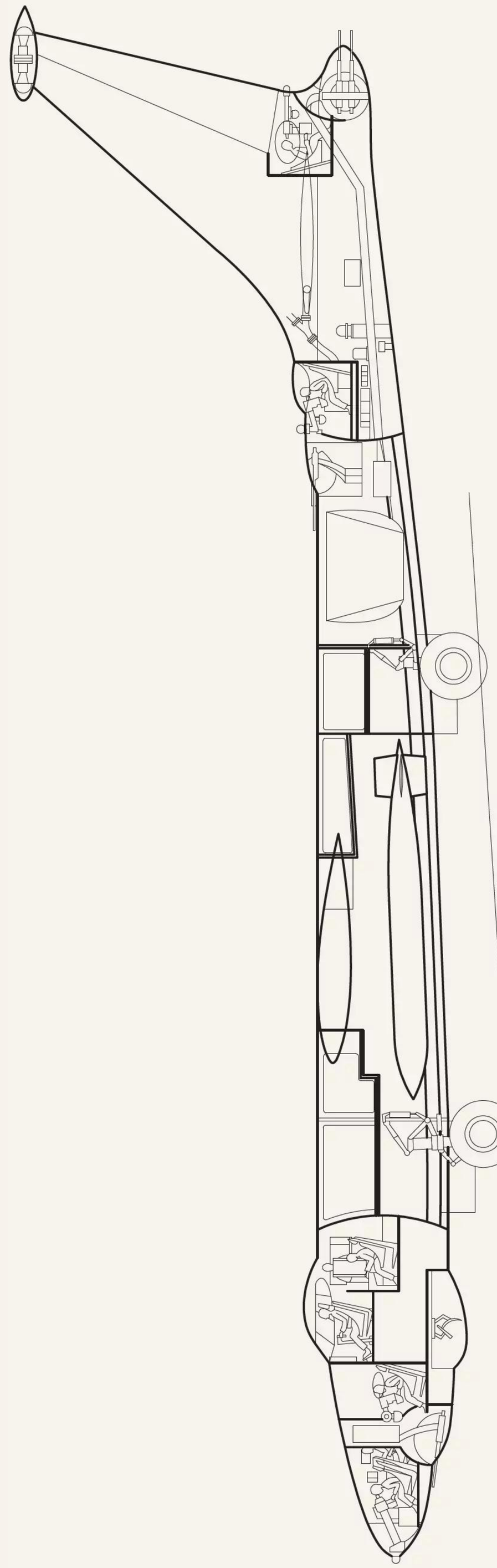

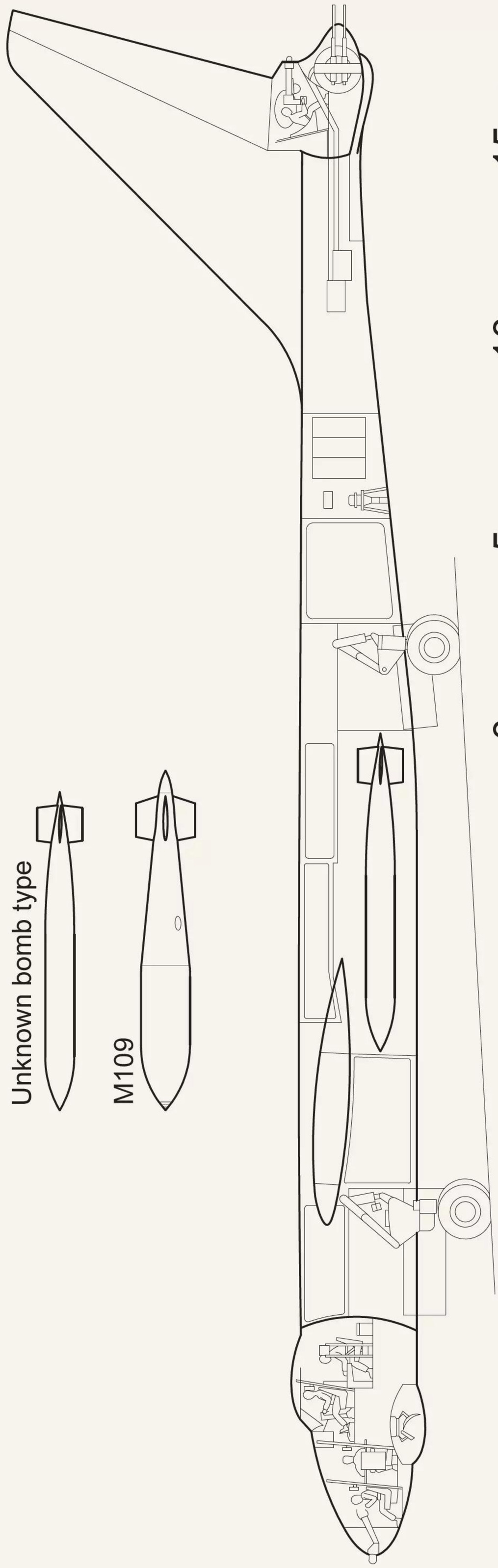

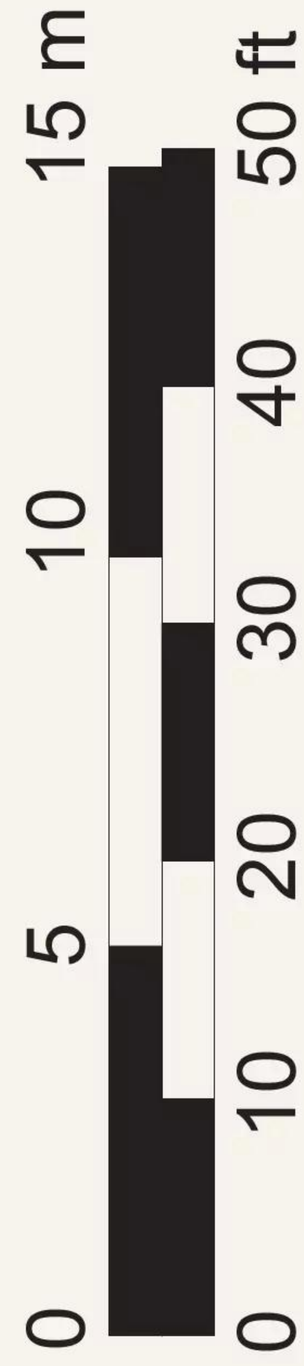

Boeing Model 483-11
XB-55

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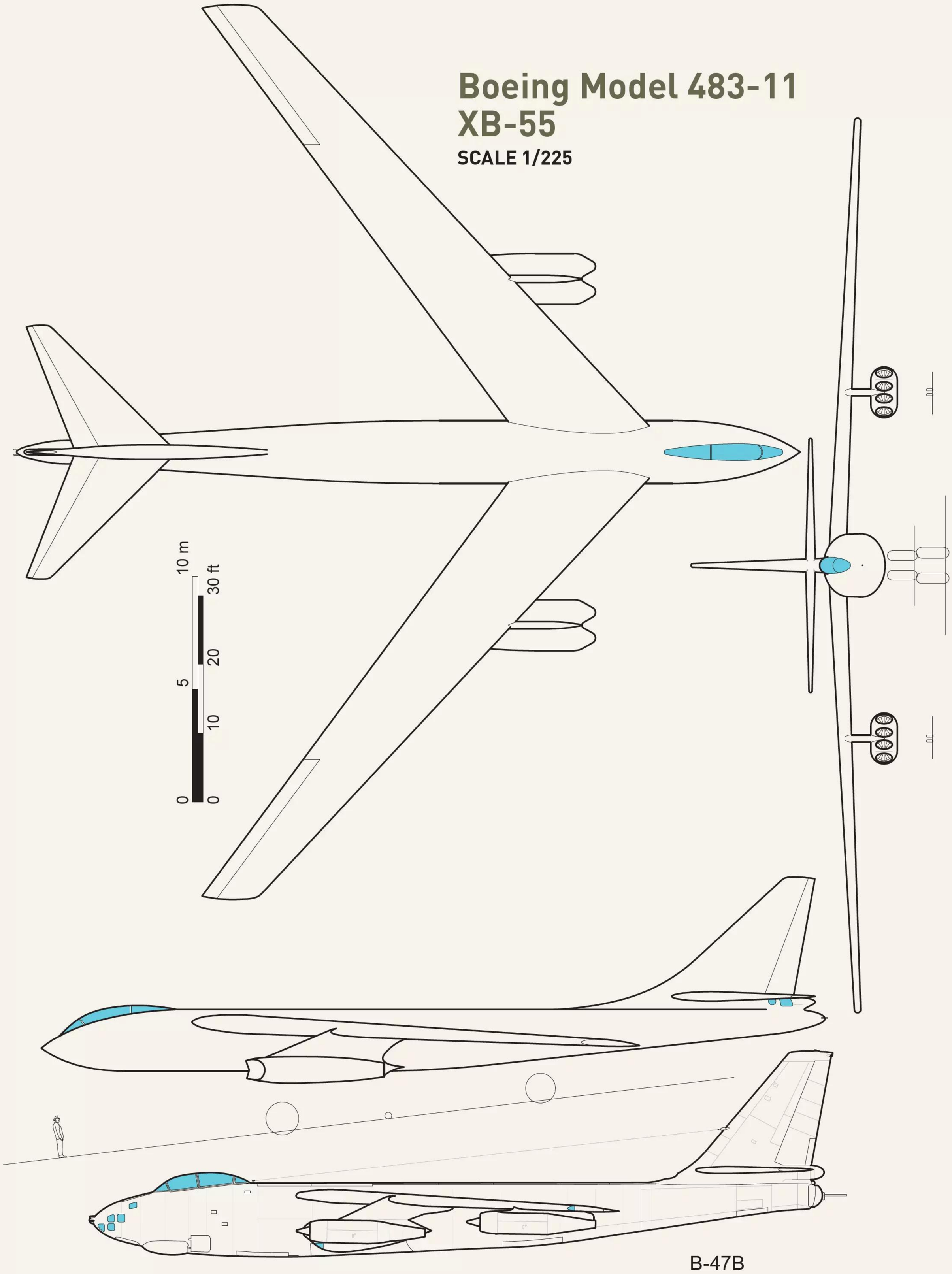
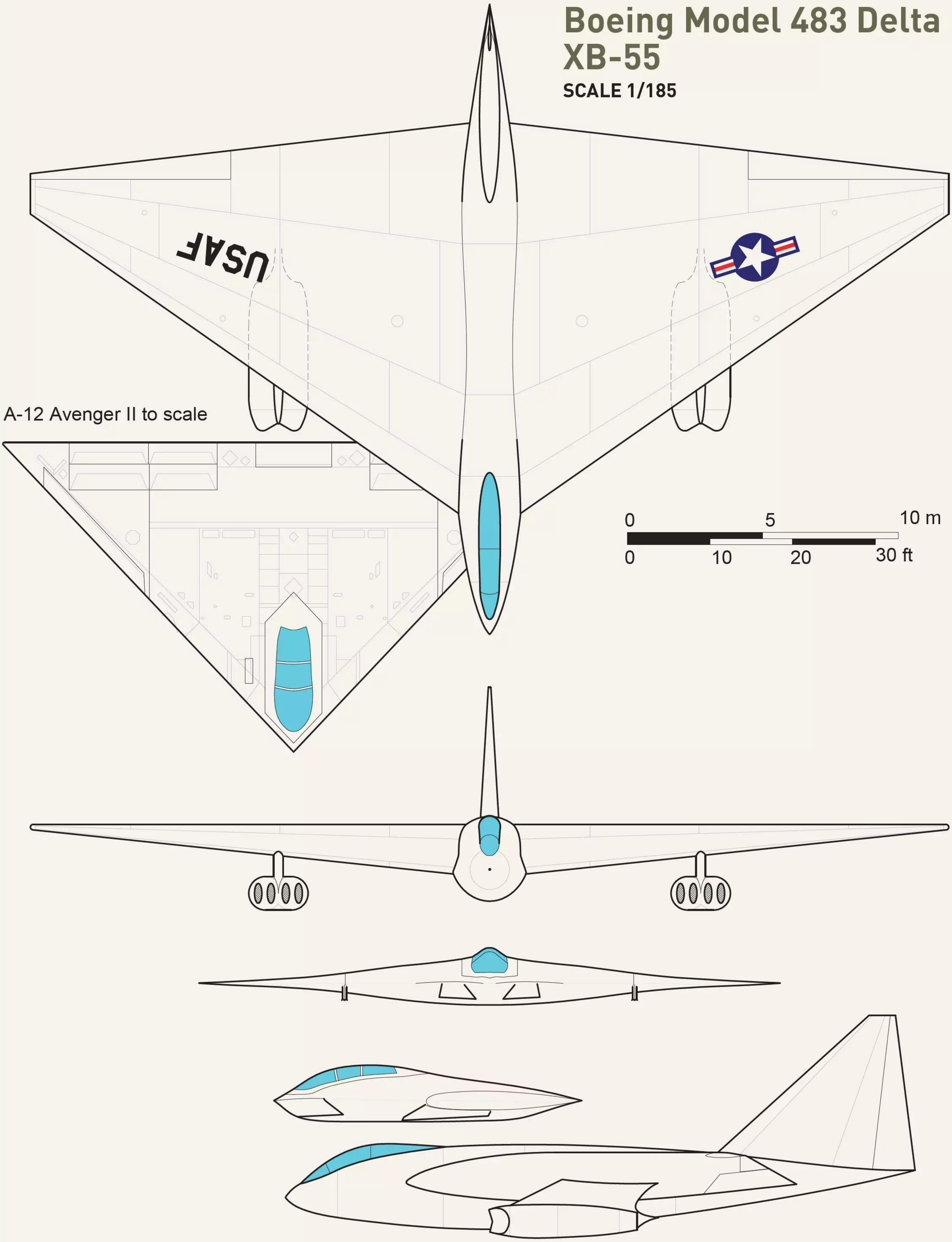


Boeing Model 483 Delta XB-55

SCALE 1/185



Boeing Model 484-106

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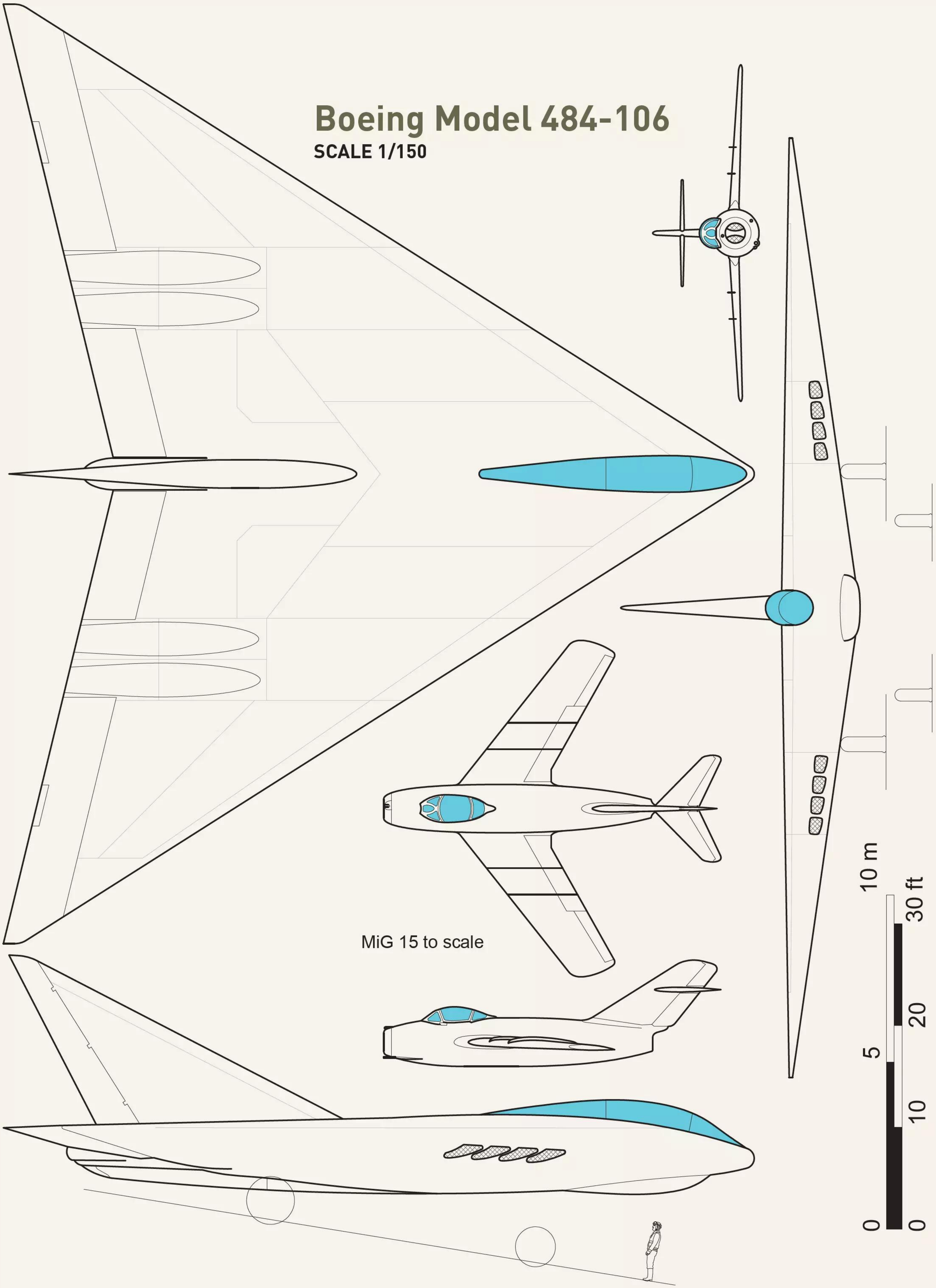


its own long inlet from the leading edge and exhaust duct to the trailing edge.

Unconventionally, the design used a four-poster landing gear arrangement. The main gear had a pair of wheels that would extend only a short distance, while the forward gear had much longer legs. This resulted in the bomber having a very 'nose up' stance on the ground. A fairing ran along the underside, starting with the ground-mapping radar and stretching to the tail. The crew of four were located in the forward fuselage under a long, narrow canopy somewhat like that of the B-47. No defensive armament is indicated in the available diagram.

With the exception of the large dorsal fin, Model 484-106 was a virtually timeless design in appearance. Boeing and Rockwell would produce very similar concepts 30 years later for 'stealth' bombers. The cockpit was less obvious and the fin was gone, but otherwise the basic configuration would hold up.

Model 484-102 was quite similar, but had a single straight trailing edge, forming a triangular planform. The vertical stabilizer also had an unswept trailing edge. Model 484-102 had something of a tail-dragger tricycle undercarriage arrangement, the tail gear being a pair of wheels that extended only a very short distance.

Boeing Model 484-230

Another early Model 484 design, 484-230 is known from a single diagram dated March 1, 1949. It was also a flying wing, but larger and more elegant than the seemingly simplistic Model 484-106. Looking not unlike a wartime German project, Model 484-230 was a swept wing with two widely-spaced vertical stabilizers and six turbojets in two banks of three on either side of the centrebody. Where the wing of the Model 484-106 had a constant thickness ratio, the wing of -230 was markedly thicker in the centre section.

The diagram seem to indicate a crew of four – two pilots, a navigator/bombardier and a gunner in a tail position much like the tailgunners position on the early B-52s. Unlike Model 484-106, 484-230 utilized a standard tricycle landing gear arrangement. There was a modest fuselage and a single central bomb bay. Small swept vertical stabilizers were fitted above the outer wing panels.

Model 484-301 was similar in configuration, but was somewhat larger and used an extended forward fuselage. The inlets were built into the leading edge of the wing rather than underneath.

Boeing Model 481-100

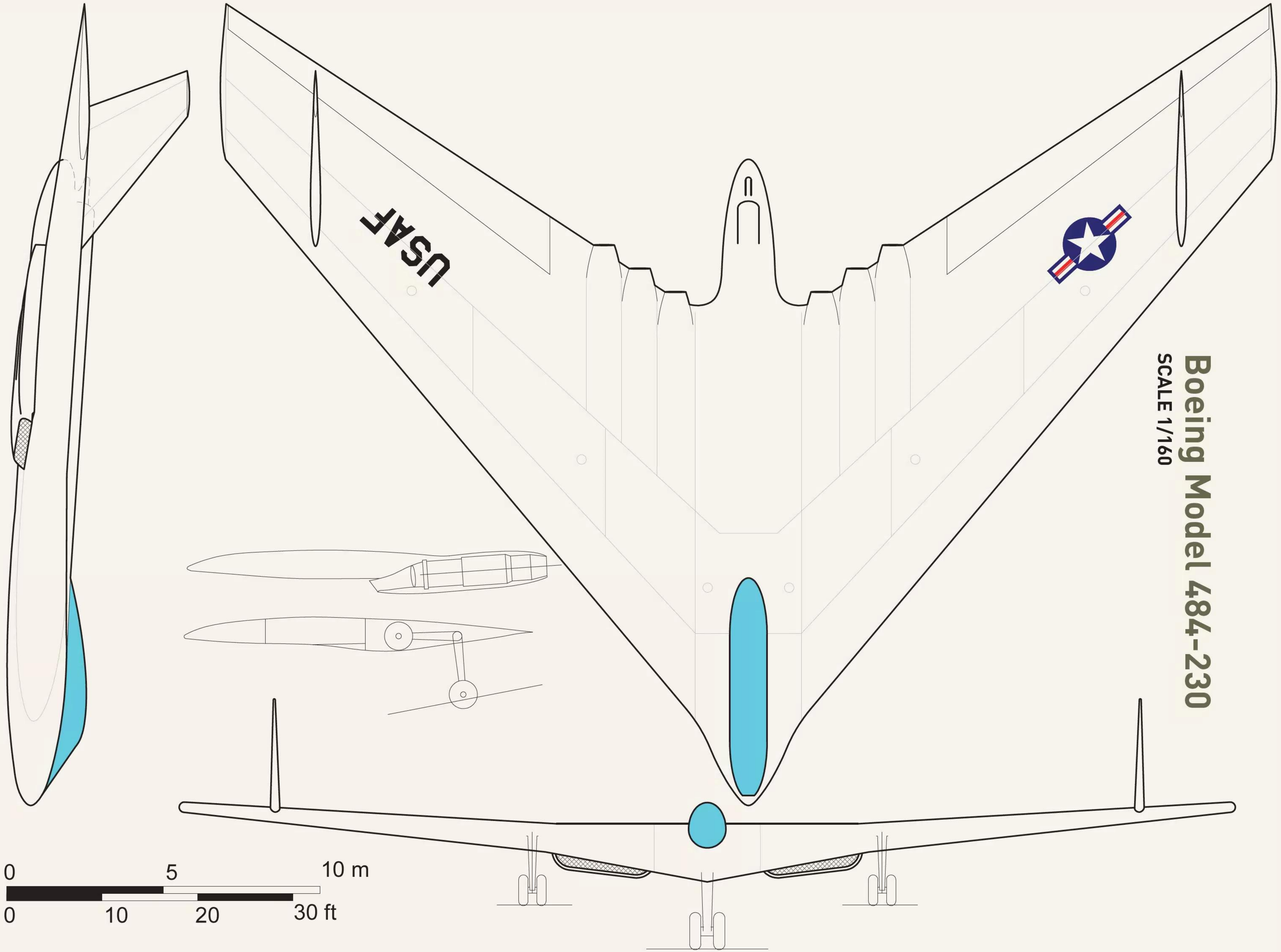
Among the Boeing designs that offered some competition to the company's own B-52 was Model 481-100. At the end of January 1948, Secretary Stuart Symington ordered that work on the Boeing XB-52 (at that time the Model 464-17) be stopped because the flying wing concept was showing great promise. It was thought that conventionally configured designs ought to be abandoned in favour of this new layout. Boeing of course disagreed and argued – successfully in the end – that the XB-52 was going to provide the capabilities the Air Force wanted, and would do so years before a new flying wing type of aircraft could be developed.

But if the XB-52 was to be cancelled and replaced with a flying wing, Boeing wanted to be the designer and builder of that flying wing. So on February 2, 1948, a design was produced at the Seattle division for a flying wing that would meet the latest B-52 performance requirements. The Model 481-100 was not a pure flying wing though; it had a substantial central fuselage as well as large wingtip vertical stabilizers. The fuselage was a practical necessity: the nearly-pure flying wings of Northrop had been designed prior to the atom bomb and could not internally carry the large atomic weaponry that the B-52 would be required to.

The Model 481-100 had a fuselage with a substantial bomb bay. The nose projected well ahead of the leading edge of the wing and bore a resemblance to the forward fuselage of the B-47. At the rear of the fuselage was a defensive gun turret with a separate pressurized cabin for the gunner. Four Westinghouse XJ-40-WE6 turbojets were semi-submerged beneath the inboard section of each wing, inlets being a long, low common scoop.

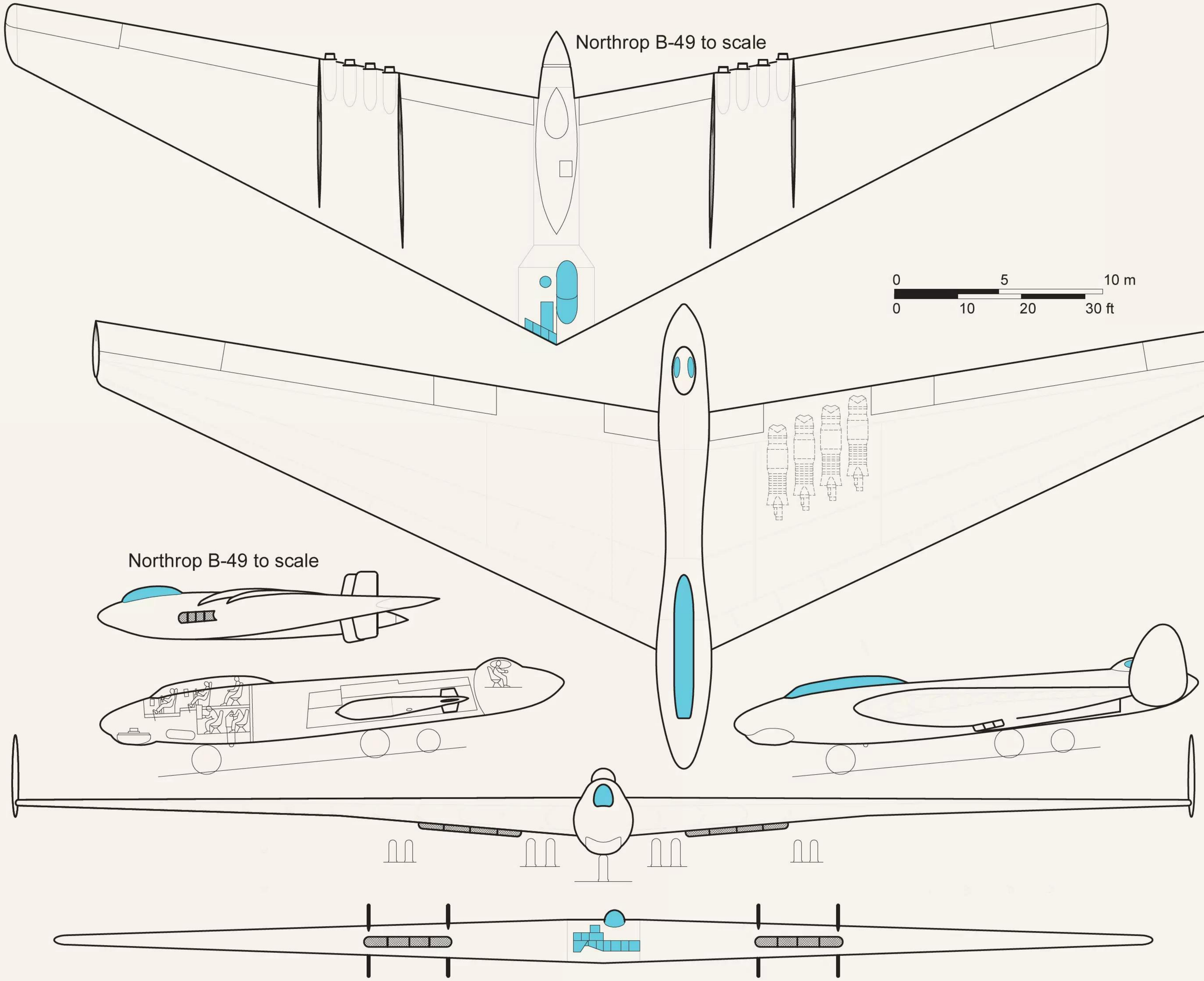
The Model 481-100 was a fairly large aircraft with 4,500sq ft of wing area, a 185ft span and a gross takeoff weight of 320,000lb. Performance data is not available, but apparently the range and speed capability of this design were not so spectacular that Boeing was ready to abandon the Model 464 and go with this new design.

The size and shape are quite close to those of the Northrop B-49; it may be that this was Boeing's attempt to redesign the competing vehicle. The central fuselage would certainly have aided the aircraft in carrying the larger atomic bombs, while the underslung inlets reduced the length of the inlet ducts and thus decreased weight and internal drag. Model 481 also had the variable thickness ratio that Boeing introduced during the XB-55's development which helped to make the B-52 wing so successful, while the B-49 had a constant thickness ratio.


Boeing Model 484-230
SCALE 1/160
USAF
0
5
10 m
0
10
20
30 ft

Boeing Model 481-100

SCALE 1/250



2 CHAPTER B-52 Development

Boeing XB-52 (Model 464-67)

The winning design for the XB-52, Model 464-49, transitioned to Model 464-67. While largely the same, there were some notable differences, most obviously the extension of the forward fuselage. Where 464-49 had the rear of the cockpit canopy behind the leading edge of the wing roots, 464-67 put the cockpit well ahead of the wing. The relatively vast expanse of spoilers on the wings were scaled down and the engine nacelles were reshaped. With those changes and an Air Force 'letter of intent' for B-52 tooling in March 1951, Boeing was ready to begin constructing two Model 464-67s.

These prototype B-52s were given the designations XB-52 and YB-52… X for 'experimental' and Y being the designation for 'prototype'. Typically an 'experimental' aircraft is built before a 'prototype', but in this case while the XB-52 (serial number 49-230) rolled out on November 29, 1951, and the YB-52 (serial number 49-231) followed on March 15, 1952, the YB-52 flew first on April 15, 1952. This was due to the XB-52 suffering damage during pneumatic system pressurization testing which required extensive repairs.

The XB-52 followed the prototype into the air on October 2, 1952. The first flight of the YB-52 lasted two hours and was powered by prototype YJ57-P-3 engines. Despite the difference in designations, the XB-52 and the YB-52 were essentially identical.

The prototype B-52s were largely similar to the production aircraft in appearance. An immediately distinguishing feature of both aircraft, though, was the cockpit. A tandem fighter-style canopy somewhat similar to that used on the B-47 was employed; it was low-drag and gave the pilot excellent visibility.

The prototypes pioneered the landing gear layout that the rest of the B-52 fleet would employ. Somewhat similar at first glance to the bicycle arrangement used by the B-47, the gear used by the B-52 was quite different. Four separate dual-wheel bogies were stored within the B-52 fuselage, but instead of deploying straight down they deployed out to the sides, twisting around so that the bogies stored fore-and-aft ended up side-by-side. This gave the B-52 not a bicycle arrangement, but a quadricycle. The B-52 would comfortably sit level on its main landing gear and not tip to one side or the other. It still employed smaller outrigger gear near the wingtips, but this was to keep the wingtips from striking the ground during heavily laden takeoffs or bumpy landings.

Additionally, the forward bogies could rotate up to 20° side to side, allowing the B-52 to do something unique: land while 'crabbing' into the wind, the fuselage of the aircraft pointed well off the axis of the groundpath of the flight. This would permit safe landings in high winds.

The prototypes had flapperons, ailerons and spoilers on the main wings. The ailerons were relatively small and located far from the wingtip; in fact, just outboard of the inboard engine pylon. A wingtip location for the ailerons would have given them more authority, but that would have put them in a much thinner section of the wing, a section much given to flexing. The inboard location was sufficient for the manoeuvring that the bomber was expected to perform.

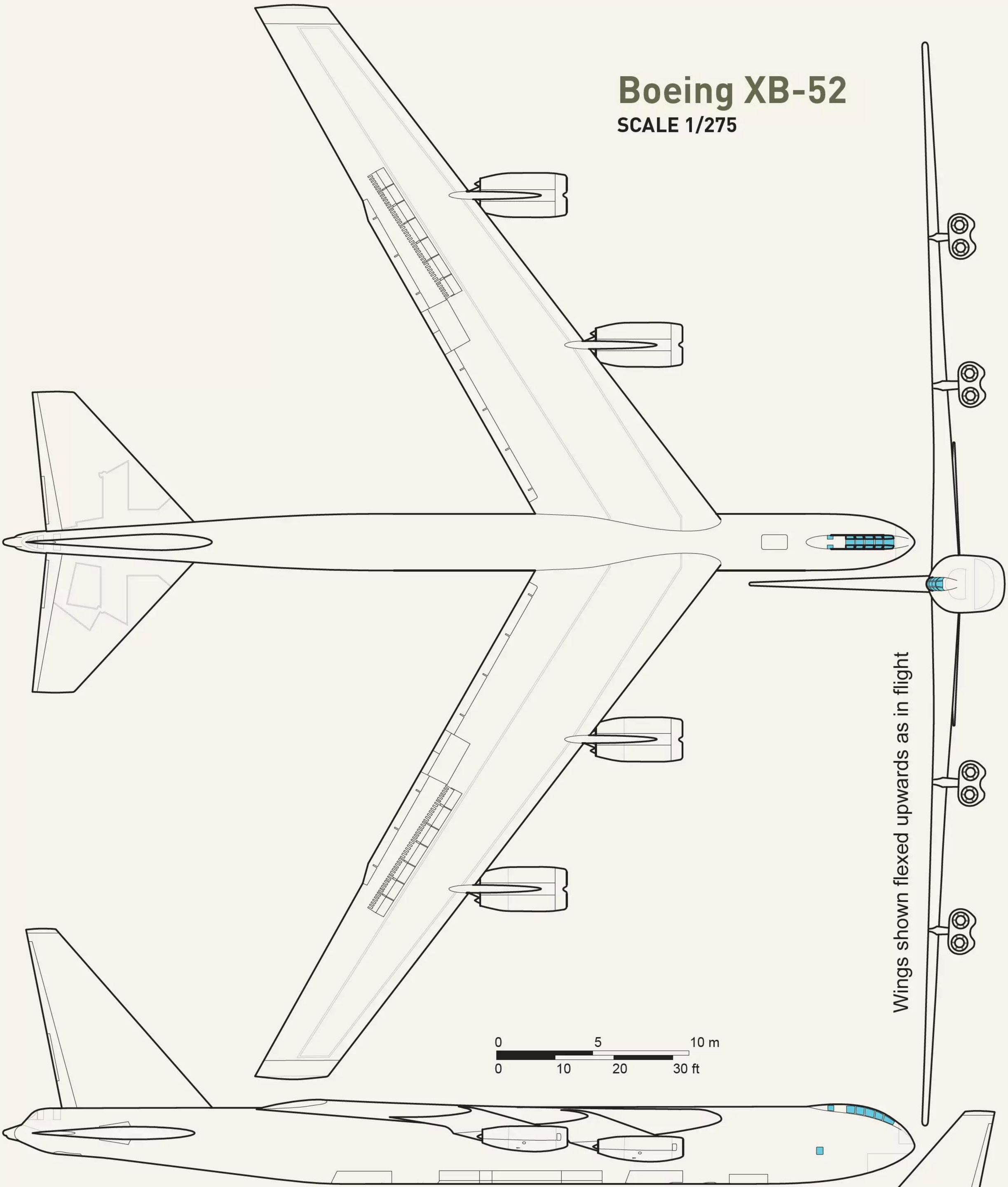
In any event, the spoilers were to take care of the bulk of the control needs of the aircraft, and the ailerons would eventually find themselves redundant. Unlike the production aircraft that followed, the prototypes did not have the capability for inflight refuelling. Neither did they, initially, have the external fuel tanks that generally graced the outer wings of production model B-52s, but such tanks were eventually added later in the testing phase.

The horizontal stabilizers were all-moving, but this was meant for trim stabilization. Actual control was via slim elevators along the trail edge. The elevators had, through the B-52F, trim tabs. An important but rarely noted feature not only of the prototype B-52s but of all B-52s that followed was the folding vertical fin. The fin was, at least until the G-model, a vast structure; too tall by far to allow the B-52 to fit within standard hangars. So it could fold over 90-degrees, greatly reducing the effective height of the aircraft. Unlike naval aircraft with wings that fold to fit in the limited space on board aircraft carriers, the folding fin is not a self-contained system – an external crane is needed to lay it over and raise it back up again.

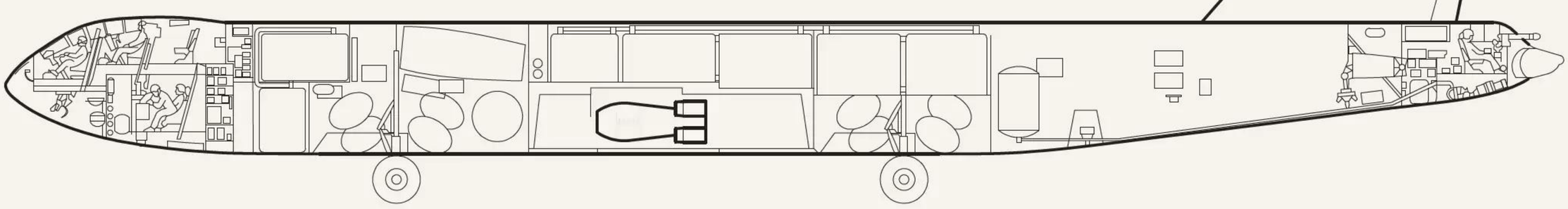
The prototypes were essentially hand-made at the Boeing Seattle factory. Production methods were not used as the jigs were not finalized; the equipment and instruments employed were also often not what would become standard. Neither prototype was fitted with defensive weapons; the tail turrets were represented by static fairings, with the frames of the proposed gunners' canopies represented with painted-on lines.

Boeing XB-52

SCALE 1/275



Inboard profile depicts operational derivative of XB-52



The YB-52 was donated to the US Air Force Museum on January 27, 1958, having flown for 783 hours. It was on display for a time but due to a 'beautification' scheme orchestrated by First Lady Lady Bird Johnson, both the XB-52 and YB-52 were scrapped sometime in the 1960s. Exactly how the official museum of the United States Air Force was 'beautified' by converting one of the most beautiful aircraft ever built into razor blades and soda cans is not adequately explained in the available literature.

Boeing B-52A (Model 464-201-0)

More than a year before the YB-52 flew, on February 14, 1951, the USAF signed a letter contract with Boeing for 13 B-52A aircraft. These would also be built at the Boeing Seattle facility, in a much more production-like process. As described previously, General LeMay disliked the tandem B-47-style of cockpit as it made communication between pilot and co-pilot somewhat more difficult than when they were seated side-by-side. At a B-52 mockup meeting held in Seattle on March 1 and 2, 1951, LeMay expressed his preference for the side-by-side cockpit arrangement.

The unbuilt YB-47C was projected to have an all-new cockpit featuring side-by-side seating and cockpit design was incorporated directly into the B-52A. This change, coupled with a slight extension to the forward fuselage, was the most obvious change from the prototypes to the A-models. A few weeks later, on March 21, the contract was revised: ten of the 13 B-52As would instead be built as B-52Bs, leaving only three B-52A aircraft. A definitive contract in December 1952 called for three B-52As and 17 RB-52B aircraft.

The YJ57-P-3 engines used on the prototypes had proven to be temperamental and were replaced on the B-52A with uprated J57-P-1W engines. These included water injection, used during takeoff to briefly increase thrust (and negate the need for the rocket assistance that the B-47 had required). While the water injection did both cool the engine and increase thrust, it also led to the distinctive smokey exhaust trails that B-52s left on takeoff.

The first B-52A was rolled out in Seattle on March 18, 1954, accepted by the USAF in June 1954 and first flown on August 5, 1954. The B-52As were built to production standards on production jigs but would never see operational service. Instead they would serve as test aircraft, with the B-52 airframe being put through its performance paces. The B-52A could be fitted with 1,000-gallon external fuel tanks, but often flew without them. The type was also equipped with the inflight refuelling receptacles behind the cockpit which would become a standard feature for all B-52 models, allowing the aircraft to roam the entire globe. The B-52As were not equipped with bomb aiming systems.

Each had six crew (one more than the prototypes): two pilots, two bombardier-navigators, one ECM operator and one tail gunner. All three B-52As were fitted with a functional tail turret complete with four .50cal machine guns, each with 600 rounds. The turret had an A-3A fire control system that could automatically aim and fire the guns using a built-in radar unit. The tail gunner was in a separate pressurized compartment at the extreme rear of the fuselage with no access to the forward compartment – there being no pressurized tunnel as there was on the B-36. In the event of a need to bail out, the entire rear fuselage aft of the gunner's station would be jettisoned; the gunner could then undo his straps and simply fall away, no ejection seat needed.

Of the three B-52As, one (52-0002) was scrapped in 1961, another (52-0001) was grounded and turned into a teaching aid and another (52-0003) was converted into the NB-52A carrier aircraft, described later.

Boeing B-52B (Model 464-201-01, -03, -04)

The first operational B-52s were the B-52Bs (Model 464-201-03) and the RB-52Bs (Model 464-201-01 and –04). Largely identical to the B-52A, the B type was at last fitted with the full suite of equipment that would allow it to aim and drop bombs.

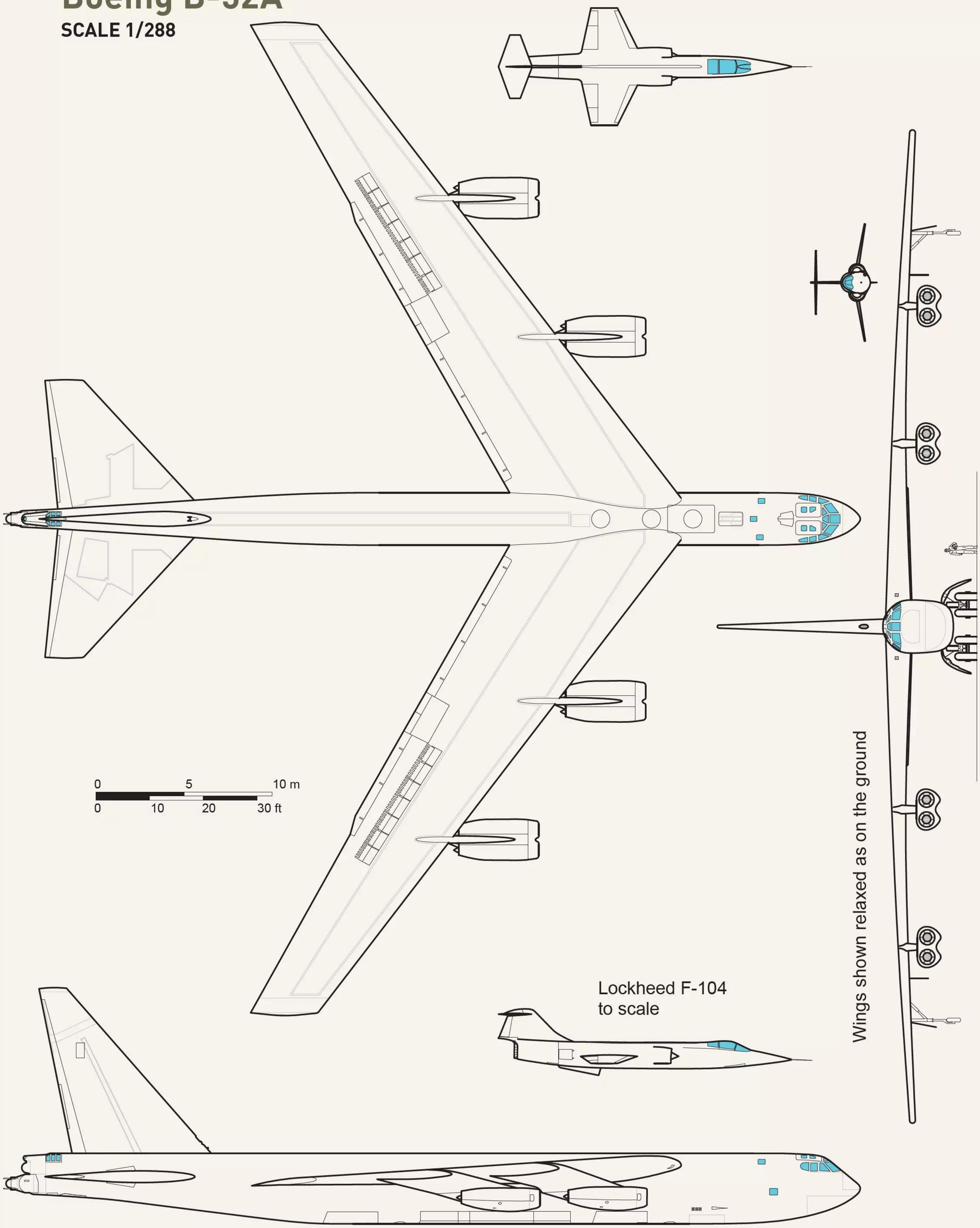
Initiated in April 1952, the first B-52B rolled out in July 1954. The first flight occurred on January 25, 1955, followed by acceptance of the first B-52B in June 1955. The B-52B was initially equipped with the K-3A bombing/navigation system from the B-36, though there was a problem: above around 35,000ft, in particular at 45,000ft where the B-52 was expected to operate, the system provided very poor visibility of the ground.

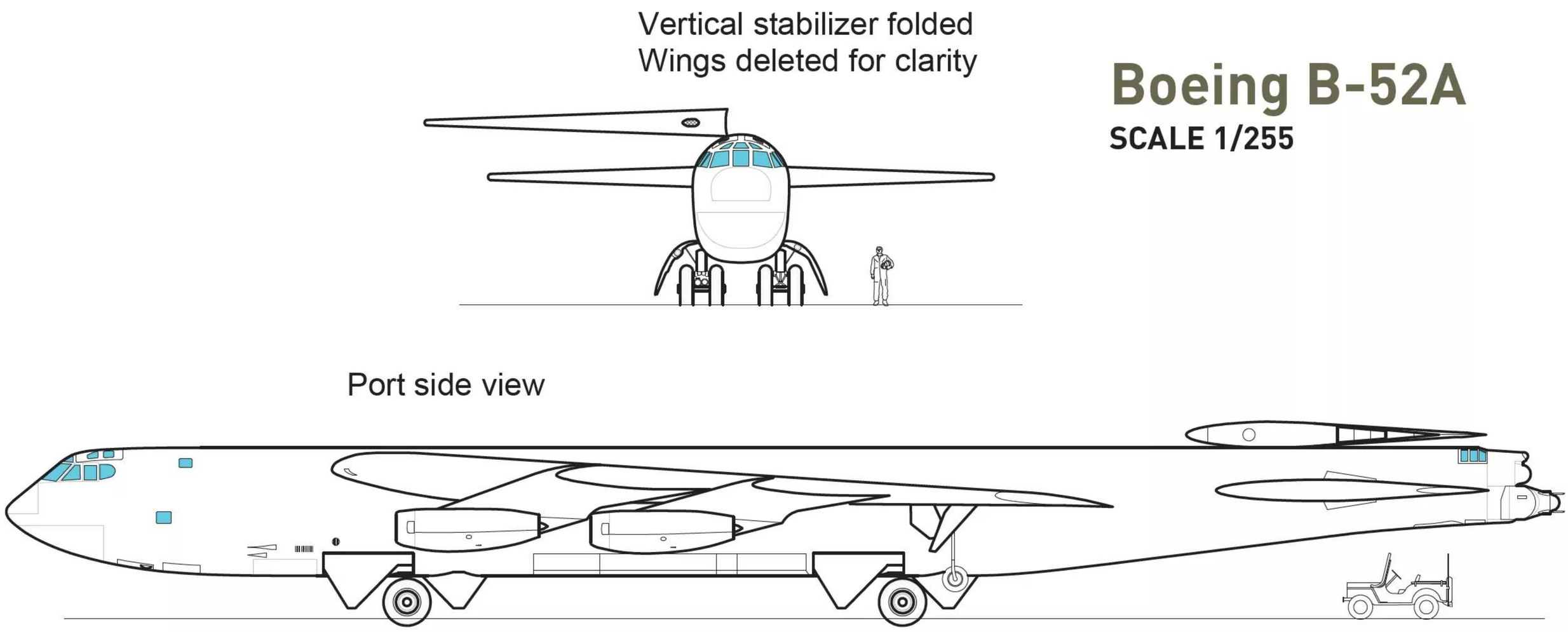
Since the bombardier could not see the targets clearly enough to identify them, the K-3A turned out to be virtually useless and was replaced with the MA-6A system. This allowed the B-52B to carry and deliver nuclear weapons such as the 8,500lb Mark 6 (a fission bomb with a yield of up to 160 kilotons) and the 17,600lb Mark 21 hydrogen bomb (with a theoretical but never tested yield of 18 megatons). It could also carry 27 x 1,000lb conventional bombs, or one 50,000lb bomb. A B-52B earned the distinction of being the first aircraft to drop a hydrogen bomb when, on May 21, 1956, a Mark 15 was dropped in the Redwing Cherokee test over Bikini Atoll. Detonating at an altitude of 4,330ft, this bomb generated a yield of about 3.8 megatons. Unfortunately, a navigation error led to the bomb being dropped about four miles off target, hitting the wrong island and ruining much of the attempt to obtain data.

A better result was obtained when, in January 1957, five B-52Bs set off from Castle Air Force Base on a round-the-world nonstop flight. Forty-five hours and 19 minutes later three of the aircraft had covered 24,235 miles (one

Boeing B-52A

SCALE 1/288





spare had failed to refuel in flight due to a frozen-over receptacle; another had made a scheduled diversion to and stop in England). Mission duration was within two minutes of prediction. This demonstrated that the B-52 could reach anywhere on earth in a reasonable time.

For defence, the B-52B series was initially was equipped with the same four-gun turret fitted to the B-52A. But another tail stinger was developed with two M24A1 20mm cannon with 400 rounds reach. These would hit far harder than the .50cal machine guns, and theoretically at greater range. To aim them, the MD-5 Fire Control System featured a larger radar in a distinctive and bulbous housing above the guns. Unfortunately this system proved a disappointment and the B-52B series ended its production run fitted with the four machine gun tail.

The RB-52B variant had special provision made in the bomb bay to accept a large cylindrical pressurized reconnaissance capsule. Several variants of this were available, all including seats for two reconnaissance operators. The pod had its own fixed fairing on the underside that replaced the bomb bay doors. In the event of an emergency, the operators were equipped with ejection seats; but given their position these necessarily fired downwards – making ejection at low altitude a risky proposition. The general purpose pod was used for photo reconnaissance, coming equipped with a bank of large (up to 36in) cameras and 24 M-120 photo-flash bombs.

An electronic intelligence capsule with antennae for receiving and instruments for recording enemy radio and radar transmissions was produced, as well as a weather reconnaissance version. At this stage in the development of the B-52 there was debate about whether the aircraft should be primarily a bomber or a recon platform; it was a debate that would rage for several years.

All B-52Bs were built in Seattle. There were 23 B-52Bs and 27 RB-52Bs. Every B-52Bs had been retired by 1966 except for one: the NB-52B.

Boeing B-52C (Model 464-201-6)

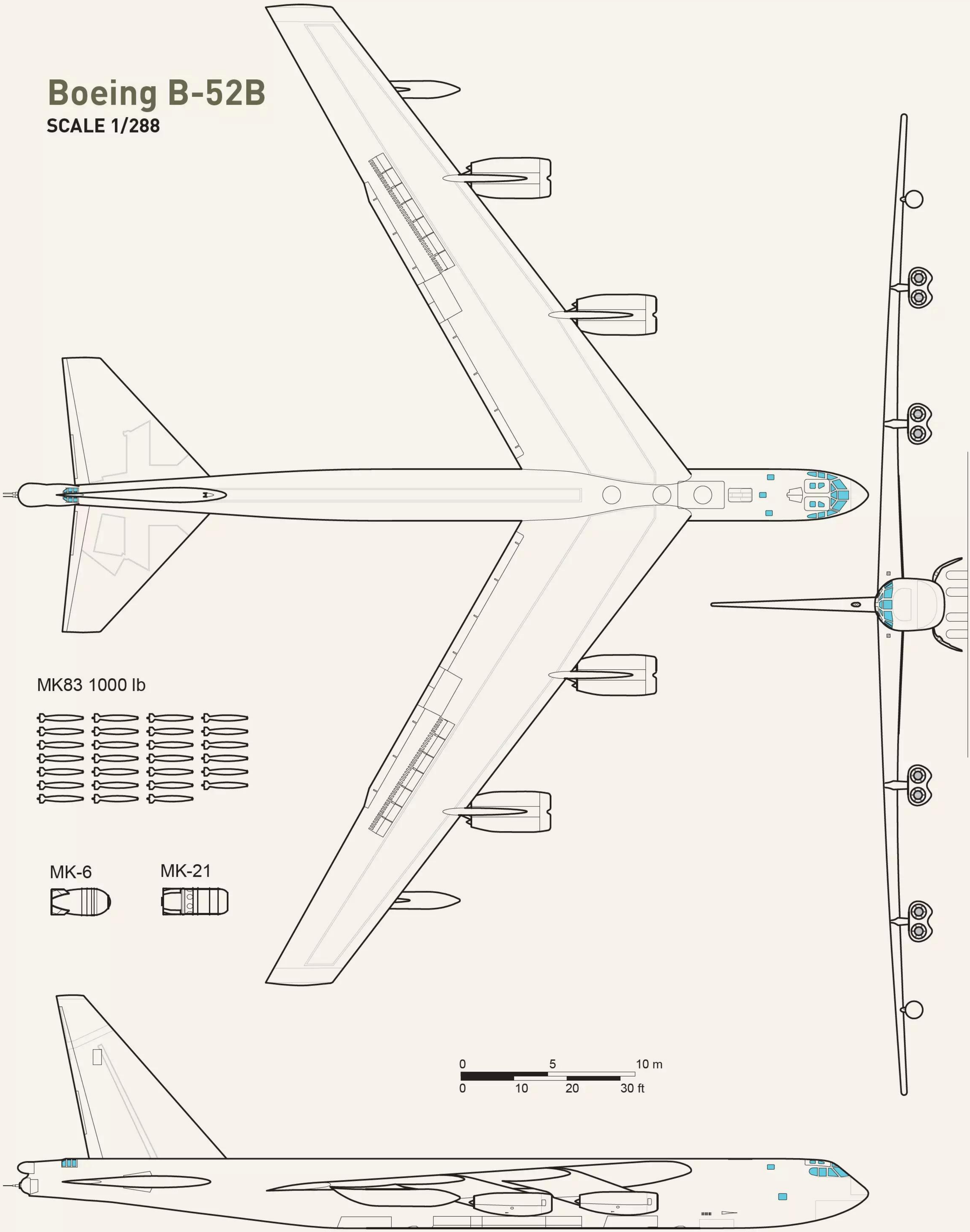
The next B-52 variant, the C-model, was initiated in August 1953. In many respect the B-52C was little changed from the B-52B, but there were some differences of note. The B-52C was built in fewer numbers than any other operational variant, only 35 coming off the production line in Seattle. First flight of the model was on March 9, 1956.

The first of the external changes was the replacement of the 1,000-gallon external tanks with much larger 3,000-gallon tanks, bringing the total fuel capacity of the aircraft to 41,700 gallons. The other visual change was in the paint: the B-52C was the first model of the B-52 to be painted with 'thermonuclear white' or 'anti-flash white' paint on the underside of the fuselage, wings, engines and tail. The upper surfaces remained largely bare metal.

The purpose of this was not camouflage; at high altitude, black or dark blue would have made much more sense. White, in contrast, would have clearly stood out. But a high-altitude thermonuclear bomber would likely still be well within sight of the nuclear detonation when the time came, and tests with high-altitude aircraft showed that bare-metal skins absorbed as distressing amount of the visible and infra-red radiation from the flash. Enough energy was absorbed that the thin aluminium skins heated up substantially almost instantly, causing warping and sometimes tearing as the skins tried to expand against an underlying unyielding structure. The white paint, using a classified composition, reflected much more of the flash and kept the structure cool… or at least cool enough to not take thermal damage. The B-47 would also find itself

Boeing B-52B

SCALE 1/288



with a similar paint job. In contrast, while the British strategic 'V-bombers' – the Avro Vulcan, Handley Page Victor and Vickers Valiant – also used anti-flash white paint, they tended to cover the entire aircraft, not just the underside. The North American Aviation XB-70 was similarly covered in overall anti-flash white.

The B-52Cs were mostly provided with the same four-machine-gun turret and A-3A fire control system that had been given to the B-52A and the first and last of the B-52Bs. However, the very last B-52C was fitted with an MD-9 fire control system, which proved to be much more reliable. The bombing/navigation system was upgraded to the AN/ASQ-48 package. With the larger fuel tanks, the gross weight was increased but the engines remained the same. The B-52C was designed to accommodate the same reconnaissance capsules that characterized the RB-52B, but the 'R' was never added to the B-52C designation. The final operational B-52C was retired to the boneyard at Davis-Monthan in September 1971, while one lone B-52C used as a flying testbed was retired in July 1975.

Boeing B-52D (Model 464-201-7)

The design of the B-52D was initiated at the same time as the B-52C, in August 1953. With the advent of the B-52D model, Seattle began to share manufacturing responsibility with another facility, Boeing's Wichita, Kansas factory. The first flight of a Wichita B-52D was on May 14, 1956, while the first Seattle B-52D flew on September 28, 1956. Wichita delivered 69 B-52Ds while Seattle delivered 101.

The B-52D was visually little different from the B-52C, sharing the same tail guns and large external fuel tanks. However, reconnaissance capsules were not included in planning for this variant, so the bomb bays did not have the features needed to accommodate them. The B-52D was to be a dedicated bomber. For this role it was capable of carrying the latest nuclear weapons such as the Mk 28, Mk 48, Mk 51 and Mk 57. It was also modified to be able to carry AGM-28 'Hound Dog' cruise missiles. The tail guns were the same four machine guns as had been featured previously, but the B-52D used the MD-9 fire control system incorporated into the last B-52C. This proved to be a much more reliable and capable system.

The B-52 had begun life as a high-altitude bomber, its survival based on flying higher than enemy interceptors could reach. That seeming invulnerability was fading fast by the late 1950s, and the B-52D was the first model to incorporate low-level bombing. This would put the bomber down in the 'clutter' of terrain, difficult for air defence radar systems to spot until the aircraft was right on top of them. But low-altitude high-speed flying presents difficulties, including being a very rough ride. While in later decades advanced technologies would be first tested and then incorporated that would reduce the turbulent ride at low altitude, in the late 1950s the new flight mode meant that the B-52D structure needed strengthening.

The 'Hi-Stress' programme, begun in the very late 1950s, took aircraft as they approached 2,000 hours and again at 2,500 hours and strengthened areas such as the aileron bay, fuselage bulkheads and numerous wing structures. Begun in 1972 and completed in 1977 was the 'Pacer Plank' programme which replaced many of the skin panels on the B-52D, not only getting rid of cracked or potentially cracked skins, but making the aircraft slightly more aerodynamic due to smother skin.

Starting in December 1965, the entire operational B-52D fleet went in for 'Big Belly' modifications to make them more capacious bomb trucks. Main bomb bay capacity was increased to either 84 x 500lb bombs (Mk 82) or 42 x 750lb bombs (M117), with a further 24 of either bomb being carried on external racks attached to pylons under the inner wing. These modifications did not change the B-52D's ability to deliver nuclear weapons, but did raise the total payload capability to around 60,000lb. The bombs were loaded into the bomb bay in pre-loaded 'clips', greatly speeding the rearming process.

This capability was turned on North Vietnam (and targets in South Vietnam) starting in 1965, with Big Belly modified B-52D and B-52F bombers laying into the jungle. Carpet bombing raids cleared large sections of forest and collapsed underground bunkers and tunnels, and filled the North Vietnamese Army and the Viet Cong with dread, as the bombs came raining down largely without warning. A hundred raids were performed in 1965… a number raised to 5,000 in 1966, 9,700 in 1967, and 20,560 in 1968. This expansion in missions was made possible due to the original base of operations in far-off Guam being replaced with a base in Thailand, merely an hour from the target.

These missions continued into 1968, expanding to bomb North Vietnamese military targets in Laos and Cambodia. The Johnson administration cancelled the bombing of targets in North Vietnam just prior to the elections of 1968, but bombed the hell out of everyone else nearby; a policy that Nixon deescalated but did not end. There were about 19,500 sorties in 1969, 15,100 in 1970 and 12,550 in 1971. By this point, everyone was largely sick of the war and just wanted to be done with it. The Nixon administration wanted to pull US forces out of frontline fighting and turn the war over to the South Vietnamese; the North Vietnamese, utterly unsurprisingly, took advantage of that and launched fresh offensives.

So the Nixon administration ended the Johnson administration's bar on bombing North Vietnam directly, and began a series of bombing raids that hearkened back to the bomber raids of the Second World War. Ports, rail yards and industrial facilities of all kinds in North Vietnam

Boeing B-52C/D/E

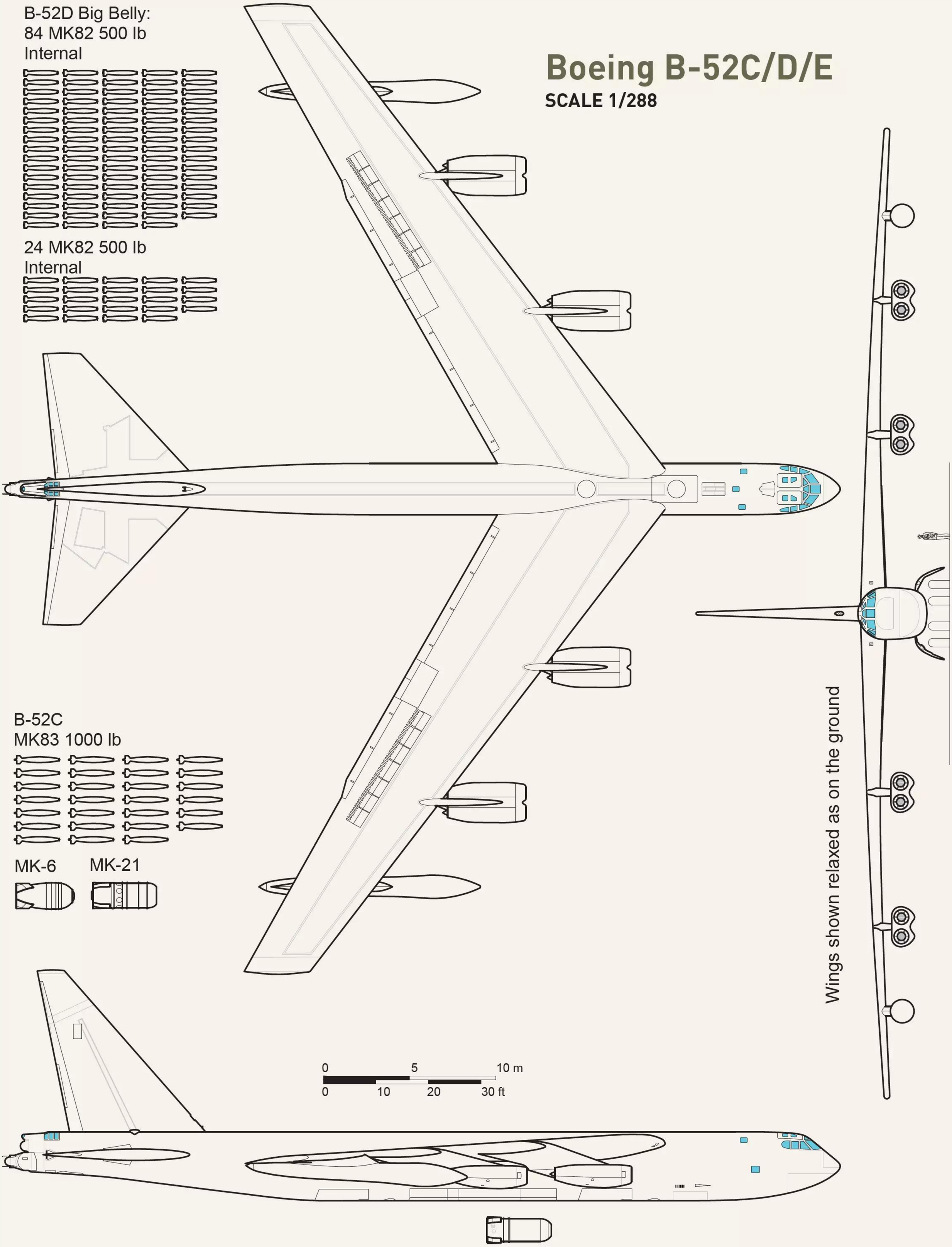
SCALE 1/288

B-52D Big Belly:
84 MK82 500 lb
Internal

24 MK82 500 lb
Internal

B-52C
MK83 1000 lb

MK-6 MK-21



B-41 thermonuclear bomb

came under heavy bombardment. An unfortunate first occurred for the B-52D on November 22, 1972, when a North Vietnamese surface-to-air missile struck and damaged one, forcing it down. Fortunately it was able to reach friendly territory and the crew escaped.

When the North Vietnamese delegation walked out of the Paris peace talks in mid-December 1972, Nixon ordered a massive concentrated strategic bombing campaign against North Vietnamese infrastructure. Over an 11-day period some 741 sorties destroyed much of North Vietnam's power generation and distribution infrastructure, a good fraction of its petroleum reserves and its desire to stay away from the peace talks. Soon after, they were back at the table in Paris and quickly reached an agreement to end hostilities.

Unfortunately, surface-to-air missiles brought down 15 of the bombers involved – the only B-52s lost to enemy action. The Soviet Union had provided a great many SA-2 'Guideline' surface-to-air missiles and to defend against this threat the B-52Ds were equipped with an extensive suite of electronic countermeasures during the 'Rivet Rambler' programme of 1967 to 1969. This included the addition of the AN/ALR-18 automated receiving set; the AN/ALR-20 panoramic receiving set; the AN/APR-25 radar homing and warning set; four of the AN/ALT-6B or AN/ALT-22 continuous wave jammers; two AN/ALT-16 barrage jammers; two AN/ALT-32H high- and one AN/ALT-32L low-band jammers; six AN/ALE-20 flare dispensers with 96 total flares; and eight AN/ALE-24 chaff dispensers with 1,125 bundles of radar disrupting chaff.

On the other hand, the December 1972 raids did also result in the only times when B-52s brought down enemy aircraft: B-52 tailgunners managing to shoot down two MiG-21 jet fighters. The last B-52 raids of the war occurred on August 15, 1973; by the end, B-52D, F and G bombers had dropped some 2.63 million tons of ordnance on South East Asia. Incredibly, the total destructive power contained within those tens of thousands of sorties, conducted over eight years, would have been equalled or surpassed by a single bomb of the type that the B-52 was actually *meant* to carry.

Perhaps ironically, the B-52Ds with the Big Belly modifications used to bomb targets in Vietnam dispensed with the anti-flash white paintjob in favor of a gloss black underside. Here the risk of damage to the underside of the aircraft from a thermonuclear flash was minimal, but the risk of taking a missile or cannon fire from a North Vietnamese MiG was very real. The use of carpet bombing raids in Vietnam has been argued about for decades, both in terms of the moral justification for it and the actual tactical value it provided; but eyewitness testimony – including from this author's own father – can attest to the fact that a number of B-52s, each laying down dozens of high explosive bombs on a stretch of jungle, resulted in landscapes that were hard to ignore or forget.

The last B-52D was retired in October 1983.

Boeing B-52E (Model 464-259)

Design work on the B-52E was initiated in May 1953. Kansas began to take the manufacturing lead, as 58 were manufactured in Wichita and 42 in Seattle. The first flight of a Seattle-made B-52E was on October 3, 1957, while the first Wichita B-52E flew on October 17.

Where the B-52D had had to be modified for the low-level bombing role, the B-52E was designed and built for that from the outset. It remained a purely nuclear strike vehicle throughout its career, never being altered for carrying conventional bombs, although it certainly could be loaded with a combination of high explosive, cluster and incendiary bombs as well as mines. The nuclear payload included two Mk 21s and two Mk 15s.

The primary differences between the B-52E and the B-52D were invisible for the outside, relating to the navigation equipment installed. In order to carry out the new low-level nuclear bombardment mission, the AN/ASQ-38 navigation system was added, along with new instruments and systems for bomb navigation and terrain avoidance.

Most B-52Es were retired by March 1970, although several went on to have interesting careers as technology and propulsion testbeds.

Boeing B-52F (Model 464-260)

The last B-52s built in Seattle were F-models, with 44 made in Washington state and 45 in Wichita. They were largely identical to the B-52Es that came before except for one noticeable difference. As well as having uprated J57-P-43W, 43WA or -43WB engines, they also had alternators added to the port sides of each engine nacelle. These resulted in a conspicuous bulge. An additional scoop inlet was introduced under the main turbojet inlet, providing cooling air for the alternators and engine oil. These new 'hard-drive' alternators replaced pneumatically-driven alternators that had been installed in the fuselage next to the wing roots.

The design of the B-52F began in May 1954, with the Seattle plant manufacturing 44 and Wichita 45. The first Seattle-made B-52F flew on May 6, 1958, the first Wichita one on May 14. While the B-52F was not included in the 'Big Belly' modification programme, it was used to drop conventional ordnance on the North Vietnamese. When the modified B-52Ds began showing up with their greater ordnance loads, the B-52Fs were withdrawn and returned to the nuclear strike mission. For this role they could carry the Mk 28, Mk 41, Mk 53 and Mk 57 bombs as well as four ADM-20 Quail decoys and two AGM-28B Hound Dog cruise missiles. The final B-52Fs were withdrawn from service in 1978.

Boeing B-52F

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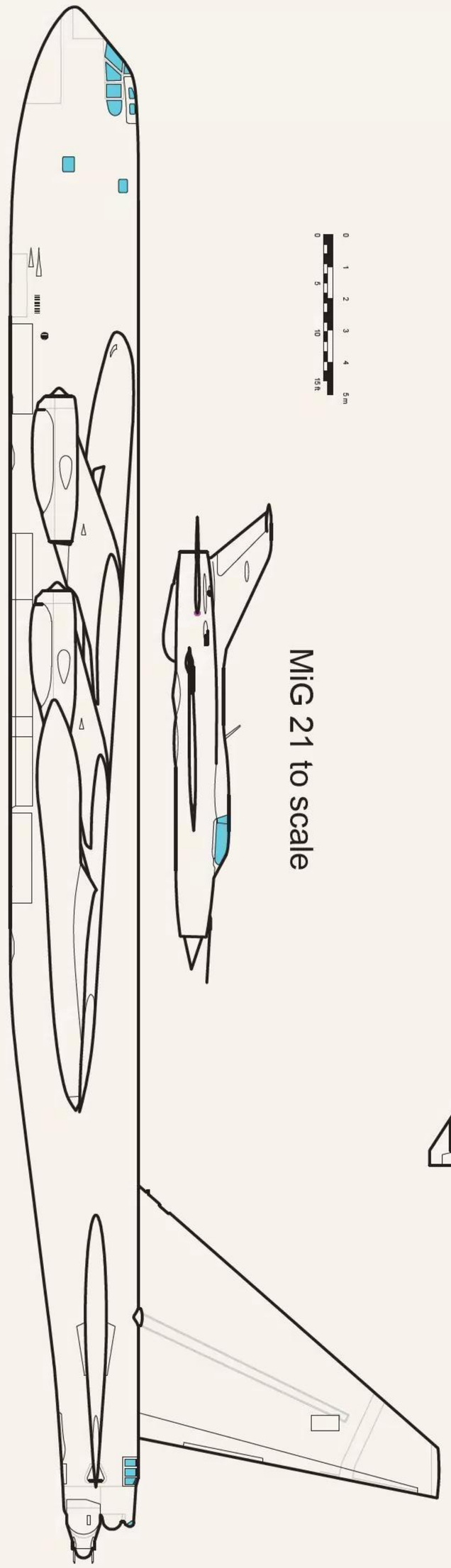
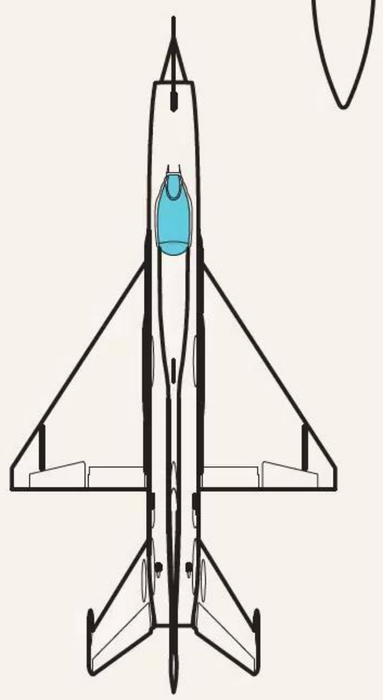
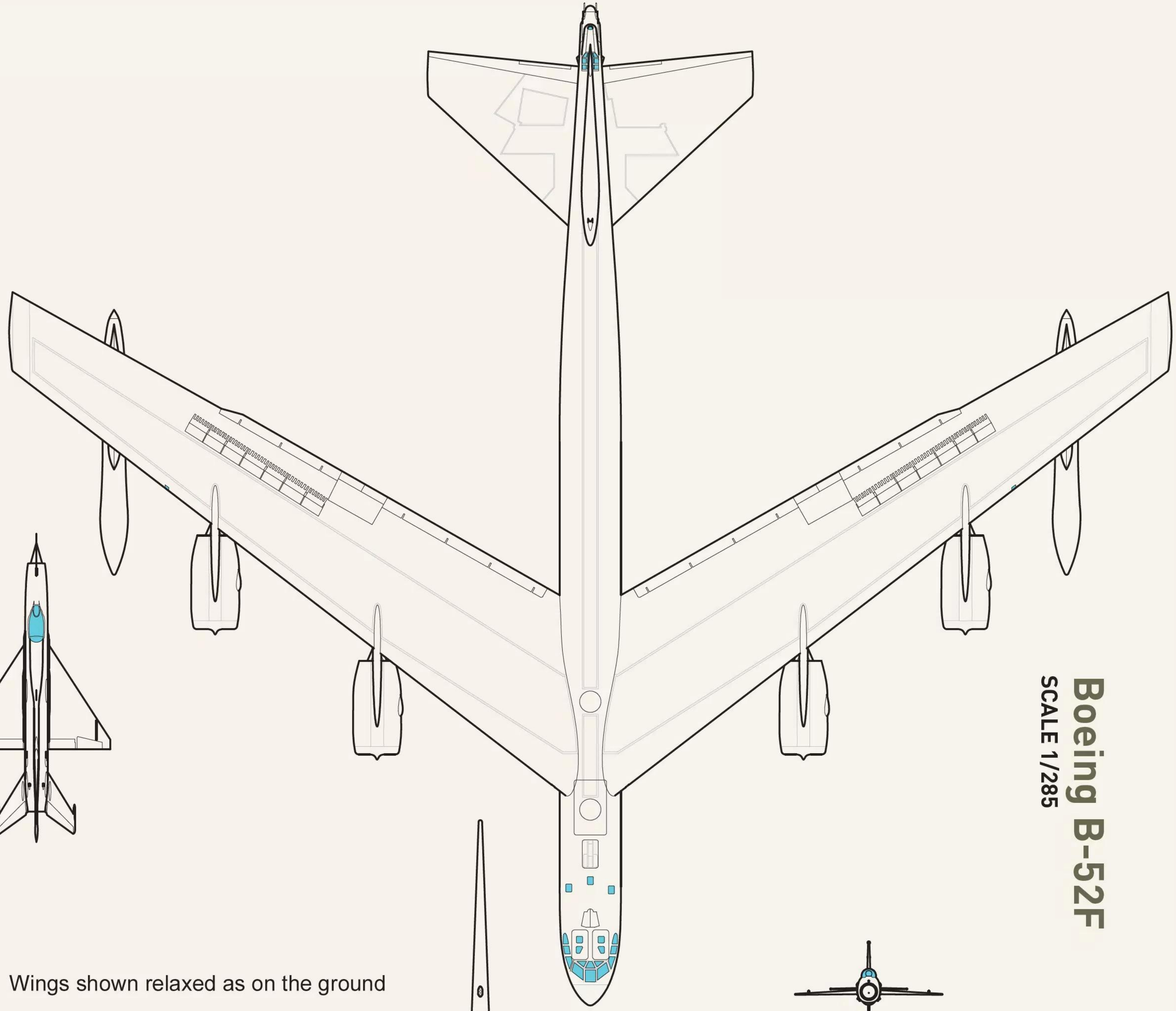
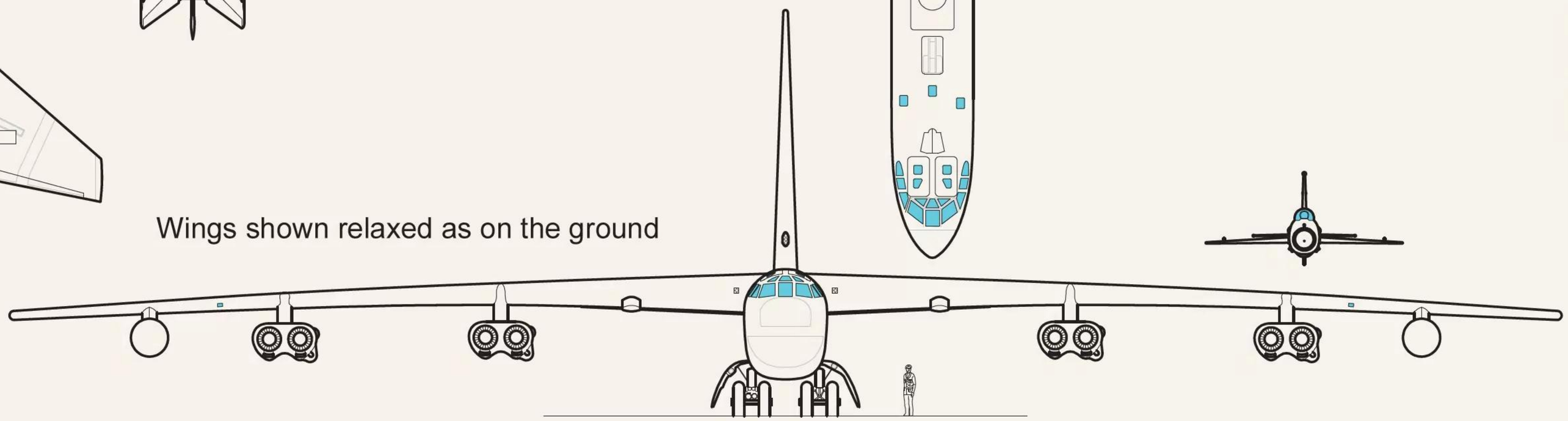


MiG 21 to scale





Wings shown relaxed as on the ground



Boeing B-52G

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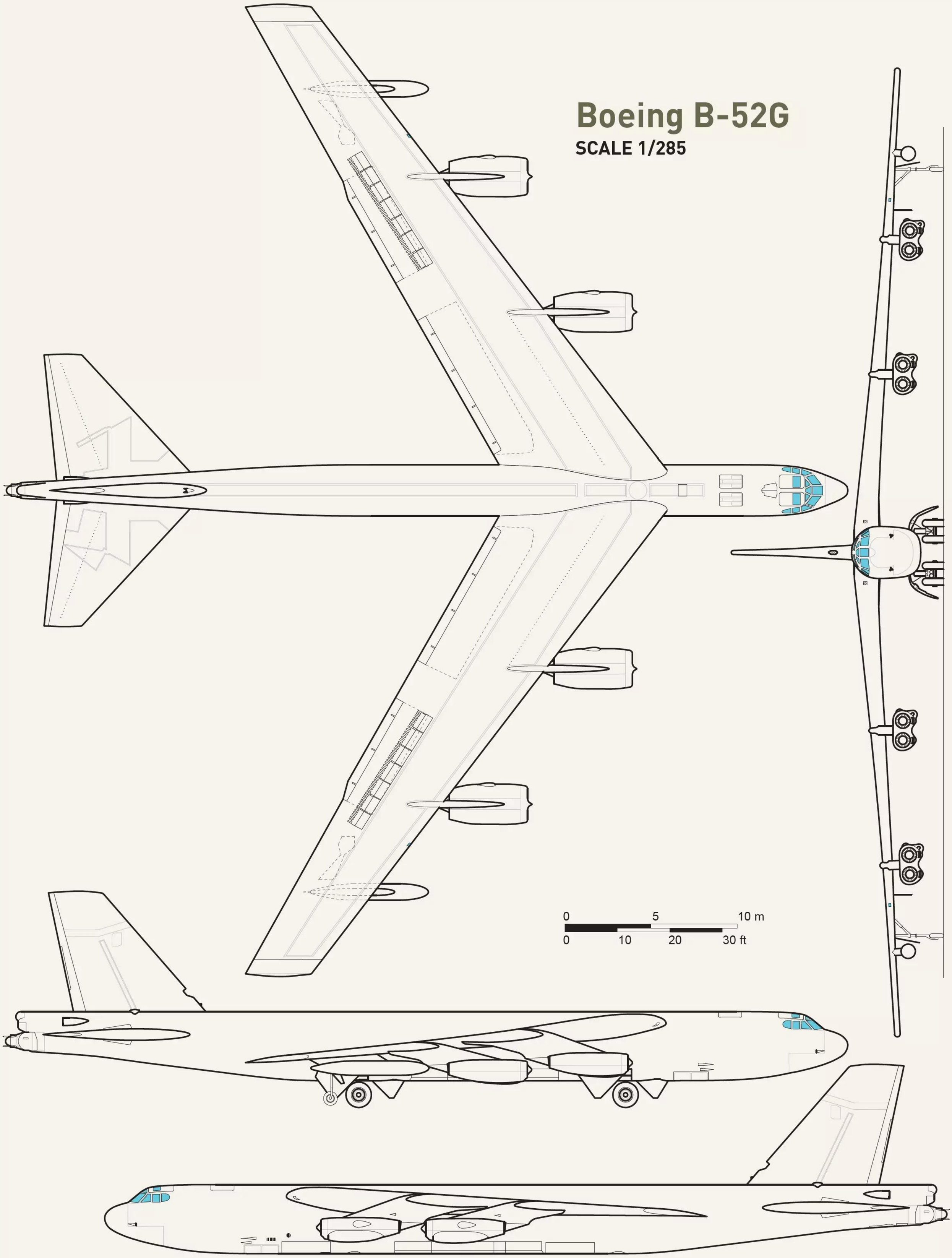

Boeing B-52G

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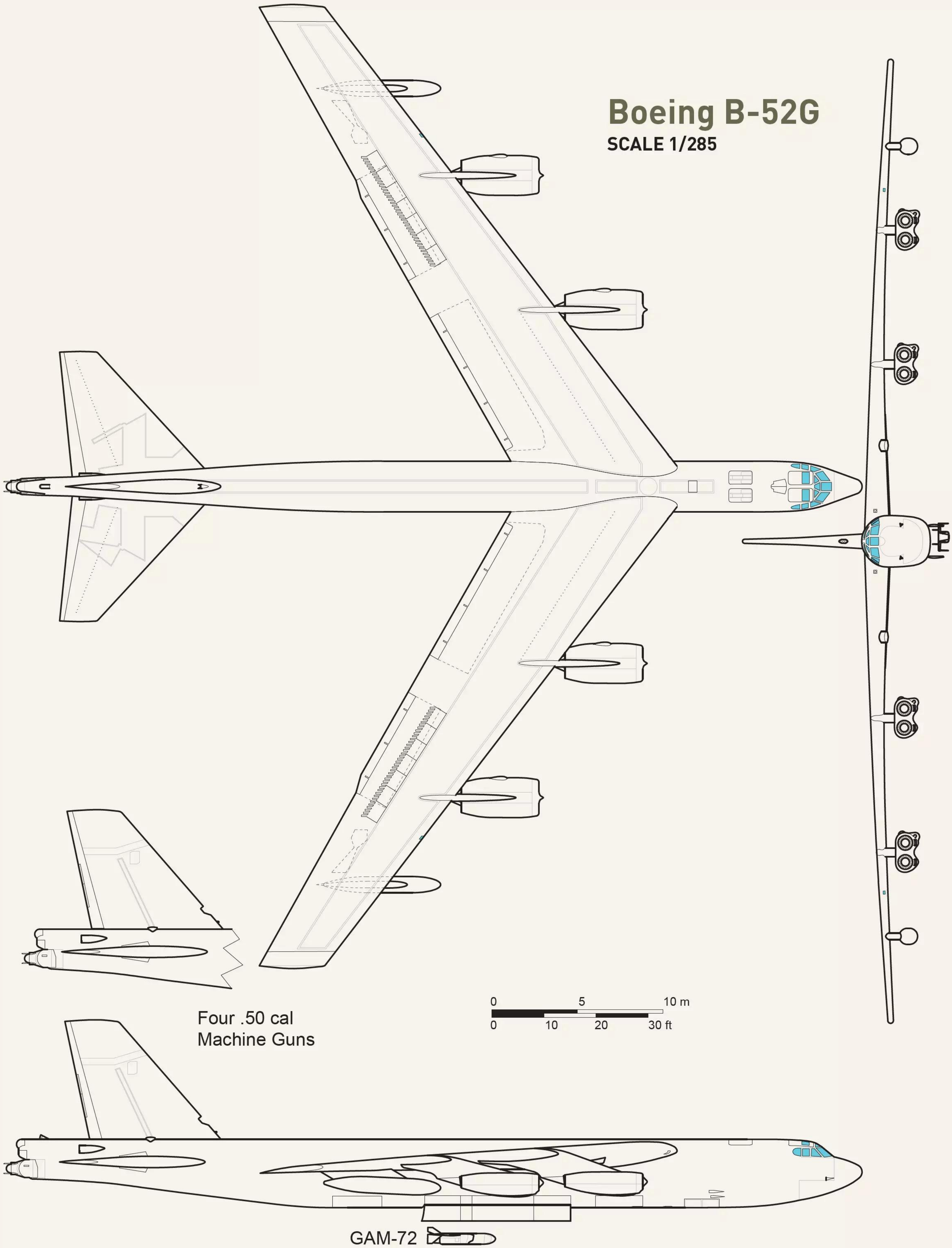

Boeing B-52G

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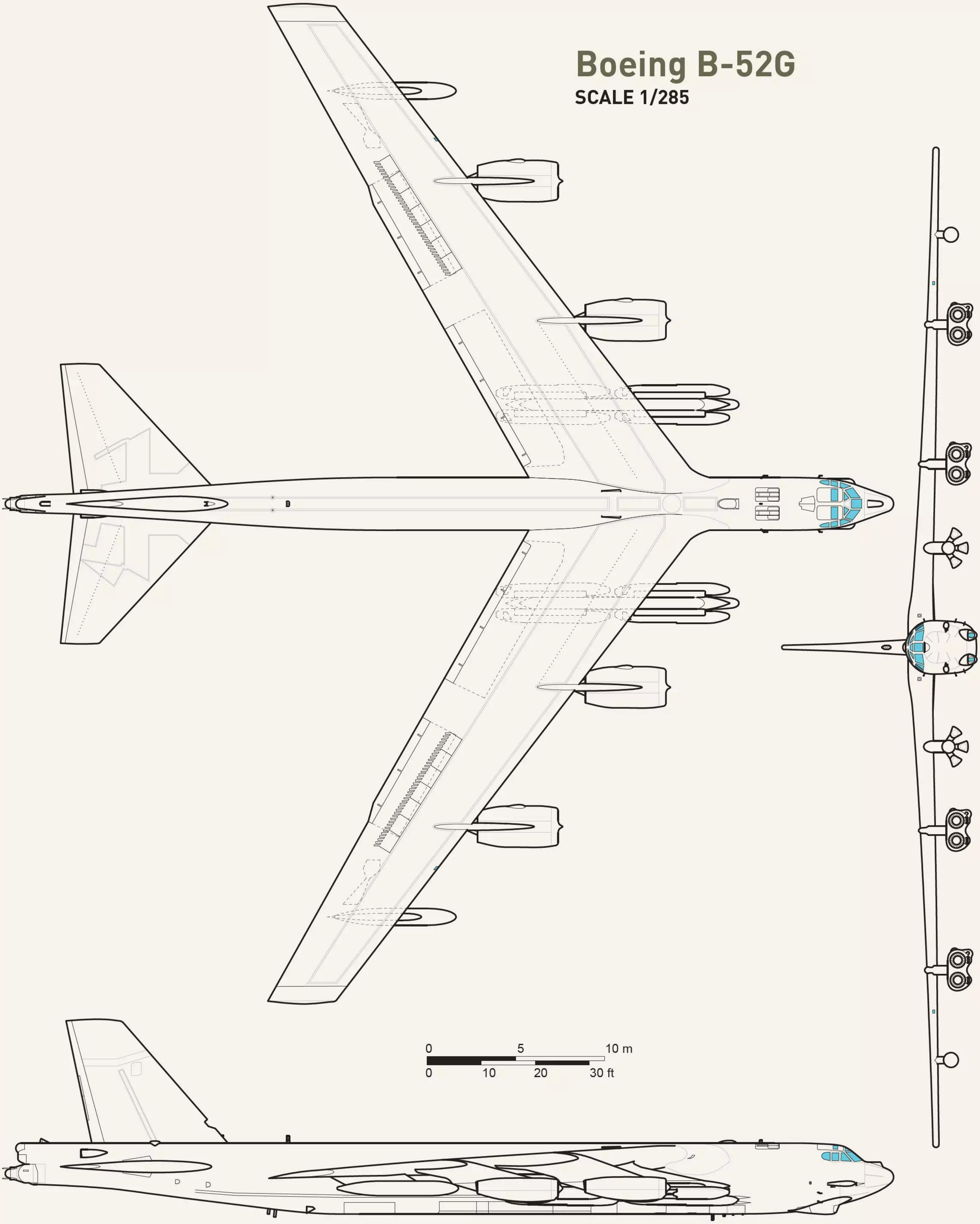

Boeing B-52G (Model 464-253)

The B-52G was the first model since the B-52A to feature a major change in appearance, as well as being the first to be built entirely at the Wichita facility. The design was initiated in June 1956 with first flight on August 31, 1958. A total of 193 were built.

The G-variant was intended to be a major advance, with a large range changes to airframe and avionics. As the Model 464-253/B-52G was being designed, the future of strategic bombing looked far faster than the B-52: the Convair B-58 'Hustler' was in advanced development and the WS-110A programme (which would lead to the North American XB-70) had just been announced. The skies would be filled with bombers reaching Mach 2 or Mach 3, powered by engines burning boron-based 'zip' fuels or even having nuclear reactors. The B-52 would look archaic fast if it was not improved, and the Model 464-253 was intended as an important step in that direction.

The obvious design change for the B-52G was the vertical stabilizer: some 8ft was cut off the tip, reducing height, area and, importantly, weight and drag. The loss of stabilizing area was made up for with the addition of a new hydraulically powered stability augmentation system. The shortened fin had been previously tested on the very first B-52A and resulted in impressive weight savings.

The vertical stabilizer change was the most obvious aspect of an overall programme to reduce structural weight. The ailerons, which had never been particularly useful, were deleted entirely, losing the weight of the hinges, actuators and control systems. Lighter materials were used throughout the aircraft structure, the flaps got lighter drive motors and the original pressurized tail gunner compartment was removed. The gunner remained but was now on an ejection seat next to the ECM operator in the forward compartment, using radar for targeting rather than visual sighting through windows.

Within the wings, the rubber bladder fuel tanks were removed and the fuel poured directly in, creating 'wet wings'. This both saved dry weight and increased fuel capacity. As a result of the greatly increased wing fuel capacity, the 3,000 gallon tanks used on the preceding models was replaced with a much smaller 700 gallon tank. The new wings were lighter than those of the previous models but while this was great for performance, they were structurally less resilient to the effects of low-level flying. Fatigue-related issues plagued the wings of the B-52G and subsequent H-model, requiring occasional repairs and modifications.

Another change to the wings was a built-in ability to carry the AGM-28 'Hound Dog' cruise missile under pylons attached to the inboard wings. While earlier models of the B-52 would be retrofitted with these pylons, the B-52G was designed and built with the requisite structural modifications, hardpoint power, plumbing and control systems from the outset.

The nose of the B-52G was changed several times. The initial version was noticeably different from the nose that had graced the B-52A through B-52F… instead of two separate radomes, one smaller one above the nose and a separate larger one below, a single-piece fibreglass fairing covered the whole nose. This new nose was longer and blunter, changing the profile of the forward fuselage. Where before the lines of the windows carried further down the nose, with the B-52G there was a distinct step where the new nose met the bottoms of the windows. There was also a slight discontinuity in the lines where the new nose was attached at the rear of the old lower radome.

Early thinking had involved the use of afterburning J75 engines on the H-model. Details on this are sparse, but it was doubtless intended to result in a single engine on each pylon (see the later description of the XB-52 with two J75 engines). While this would have decreased the total number of engines and increased thrust, it was not incorporated; the B-52G used the same engines and nacelles as the B-52F, including the distinctive alternator fairings. However, the water injection system used for increased thrust at takeoff was improved and the capacity increased to 1,500 gallons.

The B-52G was a nuclear bomber…a role that it held for many years, but not without incident. On January 17, 1966, A B-52G collided with its KC-135 tanker; both aircraft broke apart in the air and crashed near Palomares, Spain. The B-52G had been carrying four B28FI nuclear weapons; three impacted on land, one in several thousand feet of water. The pair that hit the ground had their chemical explosives detonate, spreading plutonium over a wide area and necessitating a major cleanup operation. And then on January 21, 1968, a B-52G again carrying four B28FI bombs caught fire in flight, leading the crew to bail out. The aircraft crashed onto the ice in North Star Bay, Greenland, and the resulting fire caused the high explosive components of all four bombs to explode, once again scattering plutonium hither and yon, requiring another major cleanup.

Beginning in October 1971, the B-52G and B-52H fleet underwent modification to carry a new weapon: the AGM-69A Short Range Attack Missile (SRAM). This was a relatively small solid rocket-propelled weapon that could be carried almost like a conventional bomb. Smaller and lighter by far than the Hound Dog cruise missile, the range of the SRAM was much shorter – 110 to 785 miles. Once modified, a B-52G could carry 20 of them… eight in a rotary launcher in the bomb bay and six on a pylon under each wing. Armed with a 200-kiloton thermonuclear warhead, the SRAM would have been used for not just attacking primary targets but also for SAM suppression. Its Mach 3 maximum speed meant it would reach out far enough ahead of the bomber to

destroy SAM sites before they could fire. The SRAM entered service in 1972 and was retired in 1990.

The B-52G entered the war in South East Asia in 1972 and seven were lost; six to enemy action and one to a crash in the ocean shortly after takeoff from Guam.

Between 1971 and 1976, the B-52G and B-52H fleet underwent another round of modifications. This time the fibreglass nose cones were replaced with slightly longer, slimmer noses. More importantly, the aircraft were also fitted with electro-optical sensors and improved electronic warfare capabilities. These manifested in the form of variously sized nose blisters.

Two large side by side blisters on the underside each contained a turret with a large camera. The starboard turret contained a Hughes AN/AAQ-6 forward-looking infrared (FLIR) camera; the rectangular window was made of germanium and was opaque to optical light. The port turret contained a Westinghouse AN/AVQ-22 'starlight' low light level TV camera behind an oval window. When not in use the turrets rotated 180° 'backwards' to protect them from dust, bugs and rain; also, while stowed, the windows could be cleaned with sprays of 500psi hot water. When in use, they could rotate 20° to either side and provide views of the terrain forward and below for piloting and bombing. These were useful not only for low-level night flying, but would have been handy had actual nuclear war broken out too. The pilots would be able to close off their windows with opaque flash curtains to keep from being blinded by nearby nuclear detonations, while continuing to fly using the electro-optical system to see.

At roughly the same time, the 'Rivet Ace' programme added a series of electronic countermeasures blisters onto the B-52G and H. Along each side of the nose was a small fairing for the AN/ALQ-117 active countermeasure system; another AN/ALQ-117 was later installed just above the tail turret, replacing a TV camera (the gunner was then reliant upon radar for targeting).

Along the top of the nose, just in front of the canopy, was the fairing for the AN/ALQ-122 (multiple false target generator), the AN/ALR-46 (digital radar warning receiver) and the AN/ALR-20A (countermeasures receiving set, with further sets located in the port wingtip and next to the tail turret). Further modifications and additions appeared elsewhere on the G and H models: the AN/ALQ-153 rear-looking pulse Doppler radar system (used to distinguish missiles and aircraft pursuing the B-52) was added approximately halfway up the vertical stabilizer, and four AN/ALE-24 chaff dispensers were added to the underside of each wing in the position formerly occupied by the ailerons actuators. Rivet Ace also included a 40in extension to the rear fuselage, lengthening the tail in order to install further equipment.

B-52G retirement began in 1989. Sent to Davis-Monthan, 'retired' aircraft were cut or chopped into large sections that could be easily identified by Soviet reconnaissance satellites. However, the following year surviving B-52Gs began to see action again. When Iraq invaded Kuwait, kicking off the Persian Gulf War, only the B-52G and B-52H remained in service. And while the Gulf War was seen at the time as nearly a video game, given how high-tech the American weaponry used was – stealth fighters, cruise missiles guided by GPS, bombs flying through windows, daily briefings filled with the latest exciting footage taken with night-vision scopes from great distance etc. – the B-52 was ready.

Now in their thirties, older than many of the crew who flew in them, the B-52s had been updated with the latest tech and were supported by the latest systems. When the United States kicked off Operation Desert Storm in mid-January 1991, F-117 stealth strike aircraft took out much of the Iraqis' air defence capability, and seven B-52Gs flew all the way from Barksdale Air force Base in Louisiana in order to launch 35 cruise missiles at Iraqi military communications sites and power systems. It was a testament to the effectiveness of the US Air Forces in taking out air defence systems that none of the B-52s in that raid, nor in any of the raids that followed, were shot down. Several did take damage from enemy action however, and one crashed in the Indian ocean after a raid due to electrical system failures.

Following the initial raid, B-52s were used to drop large numbers of conventional unguided bombs onto Iraqi troop and weapons concentrations during the Gulf War. In January and February 1991, some 1,645 strike missions were flown, doing great damage not only to Iraqi military infrastructure but also to the psyche of many Iraqi service personnel who witnessed and survived the B-52G raids.

The Gulf War was a great success for the B-52G, but just a few months later came perhaps one of the worst events in the history of the aircraft – in December 1991, the Soviet Union dissolved. While this was unquestionably a good thing for the world as a whole, for the B-52 it was the loss of a major reason for its existence. Unsurprisingly, retirement of the B-52G continued and was complete by 1995.

Boeing B-52H (Model 464-260)

The B-52H was the final version to see production and is the only version still in service. The design was initiated in January 1959, and as with the B-52G, the type was manufactured entirely in Wichita, Kansas. A total of 102 were built with the first example flying on March 1, 1961. The final B-52H was delivered to Minot Air Force base on October 26, 1962. As such, at the time of writing the youngest B-52 in service was approaching 60 years old… likely three times as old as some of its crew.

The most obvious change from the B-52G was the use, for the first time in the B-52's history, of entirely

new engines. Gone were the reliable but inefficient J57 turbojets. In their place were Pratt & Whitney TF33-P-3 turbofans. These engines, the military version of the JT3D engines used on such early jetliners as the 707 and the DC-8, were derived from the J57 but with the first three stages of the compressor replaced by a two-stage fan with a 1.4:1 bypass ratio. This made the engine larger in overall diameter and the resulting nacelle draggier… but thrust was increased and fuel consumption decreased. Water injection was no longer needed to boost thrust at takeoff, saving not just weight but also operational headaches. The improved engines greatly increased the unrefuelled range of the aircraft.

Another visually apparent change from the B-52G was the removal of the four .50cal machine guns in the tail. In their place was a single 20mm M61 'Vulcan' Gatling gun. Capable of a respectable 6,000 rounds per minute, this weapon – eventually the standard used on nearly all USAF and US Navy fighters – had far greater hitting power than the earlier machine guns, as well as greater range. As with the B-52G, the gunner was located in the forward crew compartment. The cannon was equipped with 1,242 rounds – enough for perhaps 12 and a half seconds of firing (short bursts recommended).

The gunner used the AN/ASG-21 fire control system, reliant solely upon radar to aim. But a decision was made in 1991 to remove the tail gun entirely from the B-52H. The days when the threat to a bomber was a fighter wandering up behind it, guns blazing, were long over; realistic threats came in the form of surface-to-air missiles and air-to-air missiles, neither of which the tail gun could really counter. So the guns and the gunners were removed, the hole in the tail covered with a flat plate.

The B-52H was intended from the outset to be equipped with GAM-87 Skybolt air launched ballistic missiles. When these were cancelled, the AGM-28 Hound Dog was the fallback until the AGM-69A SRAM became available, as well as nuclear bombs in the bomb bay. Over time a large range of other weapons were developed for use on the B-52H – including the AGM-86 Air Launched Cruise Missile, the AGM-129 Advanced Cruise Missile, the GBU-57 Massive Ordnance Penetrator, a wide array of conventional unguided and laser guided bombs (guided by a laser beam projected from the AN/AAQ-28(V)1 'Litening II' or AN/AAQ-33 'Sniper' pod suspected beneath the starboard wing), glide bombs such as JDAMs, JSOWs, and SDBs, the AGM84 Harpoon anti-shipping missile, the AGM-158A Joint Air-to-Surface Standoff Missile (a turbojet powered cruise missile akin to the ALCM, but smaller) and the ADM-120 Miniature Air Launched Decoy (a modernized 'Quail', in essence).

The B-52H was originally delivered with the same single-piece, somewhat blunt nose that graced the B-52G. But it was replaced with the same pointier nose and electro-optical vision system that the B-52G received, along with the electronic warfare systems and blisters of the 'Rivet Ace' update. However, the B-52H was granted even more bumps and protrusions. Atop the fuselage between the wings (about two-thirds of the way back along the chord) and along each side of the aft fuselage are blisters for the AN/ARR-85 Miniature Receive Terminal, a communications system designed to survive in a nuclear war environment.

Atop the fuselage between the wings (just aft of the leading edges) is a circular GPS receiver; ahead of that is a raised fairing containing the AN/ASC-19 AFSATCOM (satellite communications system). Along the underside are a number of blade antennae for electronic countermeasures.

The total population of operational B-52s by the mid-1990s had been reduced to 85 B-52Hs and Strategic Air Command itself was done away with on May 31, 1992. The B-52 now shared nuclear strike duties with the Rockwell B-1 and the new Northrop B-2 – but there seemed to be nobody around to drop nuclear weapons on. After a brief lull in the wake of the Soviet Union's dissolution, a genocidally bloody civil war erupted in the former Yugoslavia.

Beginning in 1992, Serbia, Croatia and Bosnia decided that the time for fellowship was over and into 1995 they fought the first real war Europe had seen since the Second World War. The hatred didn't end with the Dayton Accords either; soon enough Serbia was fighting to retain the city-state of Kosovo. NATO decided that enough was enough and sent in armed aircraft and ground forces to put a stop to it. On March 24, 1999, NATO began air operations against Serbian forces. This involved the B-52H, the B-1 and the B-2. The B-52s launched cruise missiles, rained down Mk 82 unguided bombs and even dropped leaflets warning of further B-52 raids. As in Iraq, troop concentrations and columns of armour proved vulnerable targets for B-52s dropping simple gravity bombs. Serbia finally threw in the towel on June 10, 1999, bringing the air campaign to an end.

Once again, the end seemed near for the B-52; nobody left to nuke, and few enough targets to carpet bomb.

And then came September 11, 2001. The attacks on the Pentagon and the World Trade Center led directly to one war and indirectly to another. Operation Enduring Freedom began on October 7, 2001, with B-52s operating from the British island of Diego Garcia in the Indian Ocean bombing al-Qaeda and Taliban sites throughout Afghanistan. A new capability was on display: the turbofan engines of the B-52H – at this point around 40 years old – allowed it to loiter, heavily laden, for extended periods at high altitude. Using co-ordinates provided by forward air controllers or spotters on the ground, the B-52 could pick out individual targets and put GPS guided bombs

Boeing B-52H

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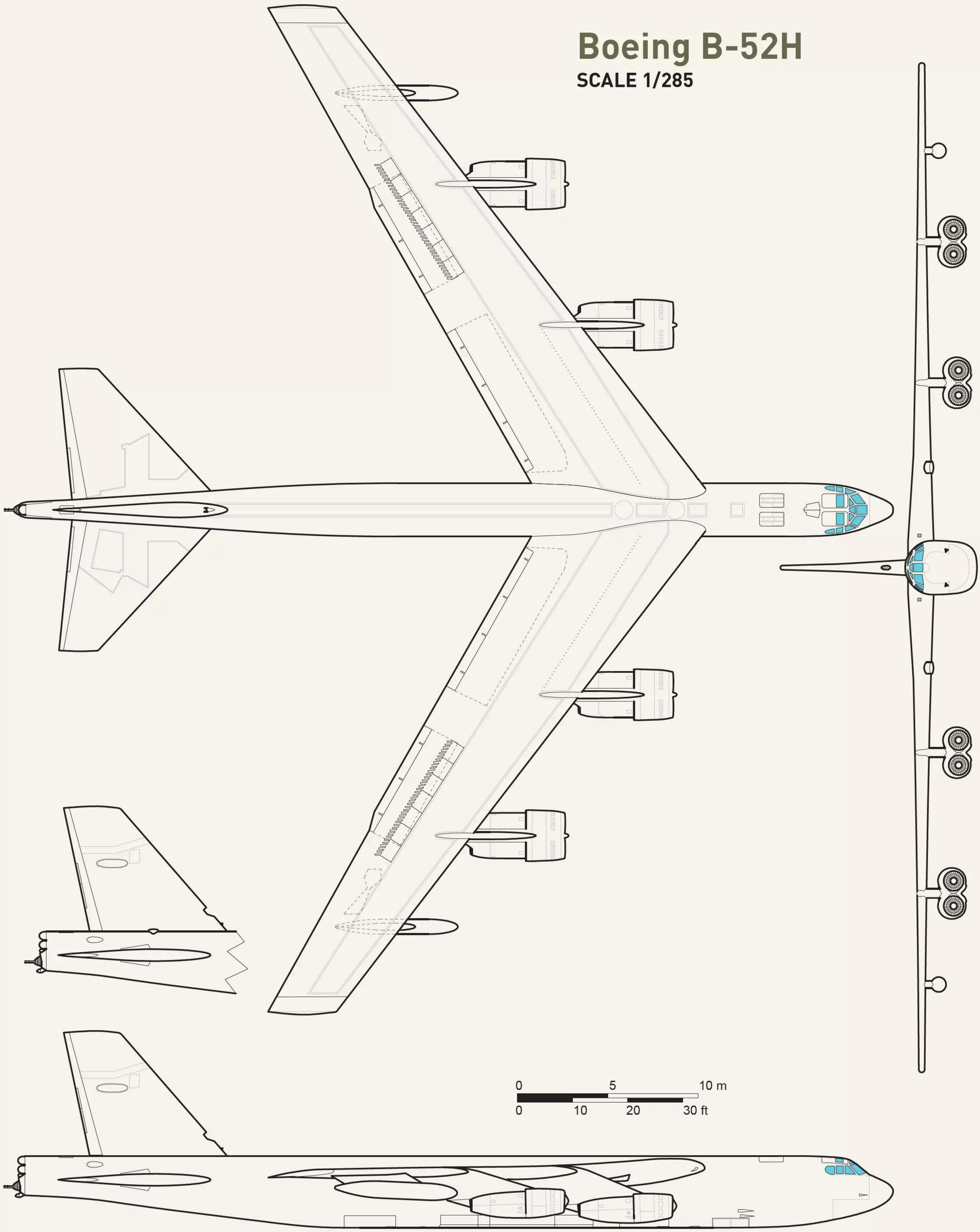

Boeing B-52H

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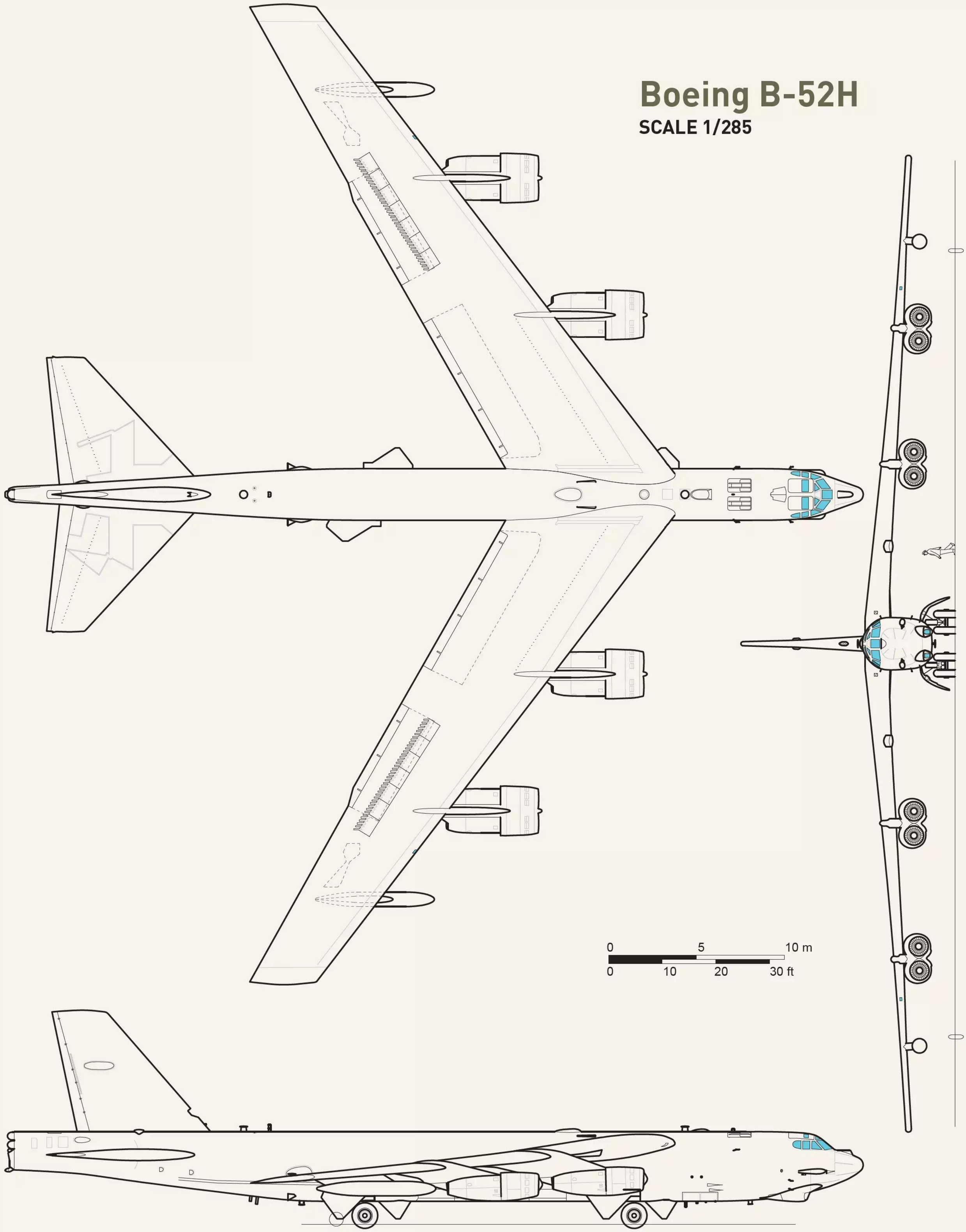

Boeing B-52H

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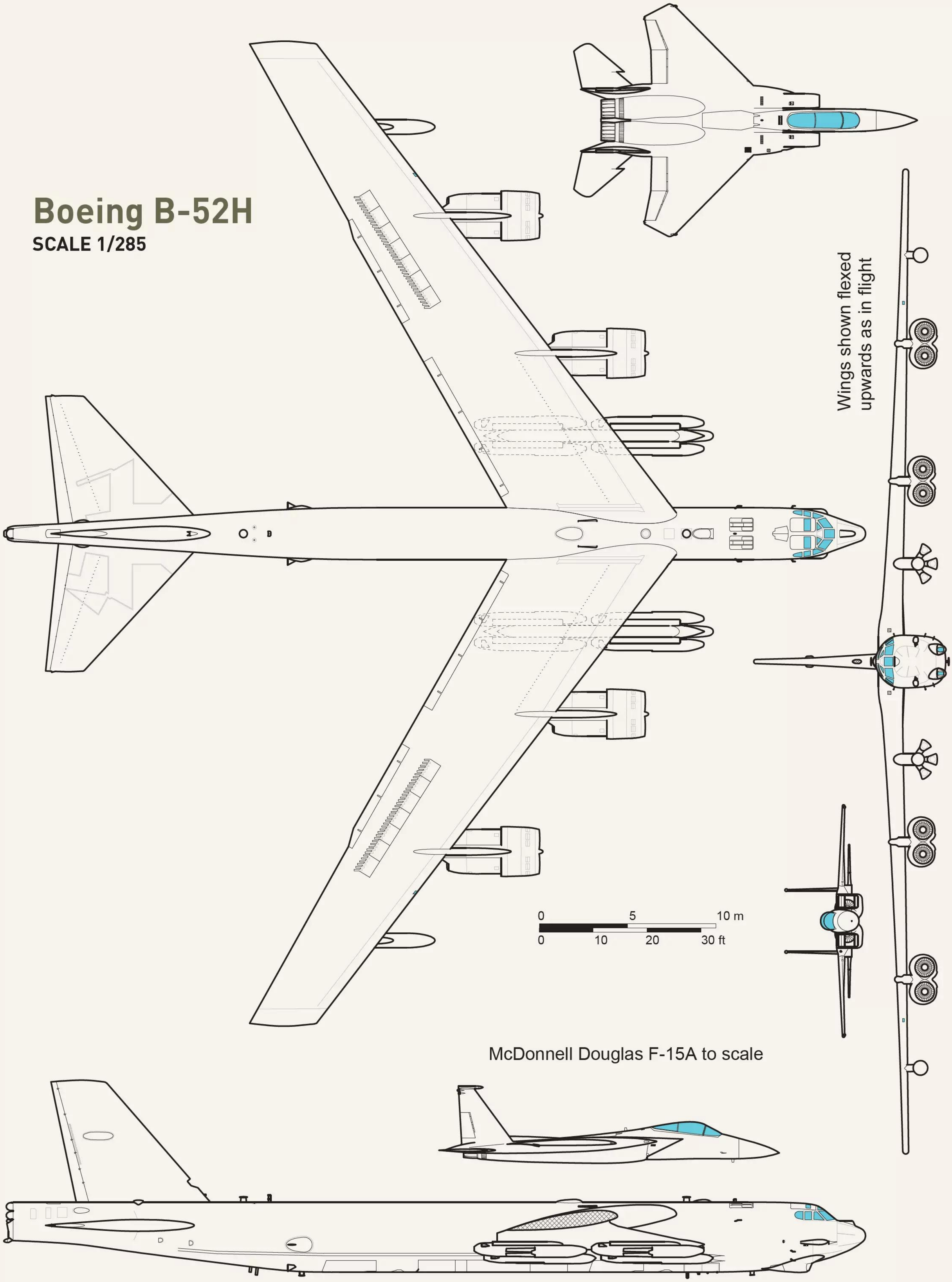

Boeing B-52H

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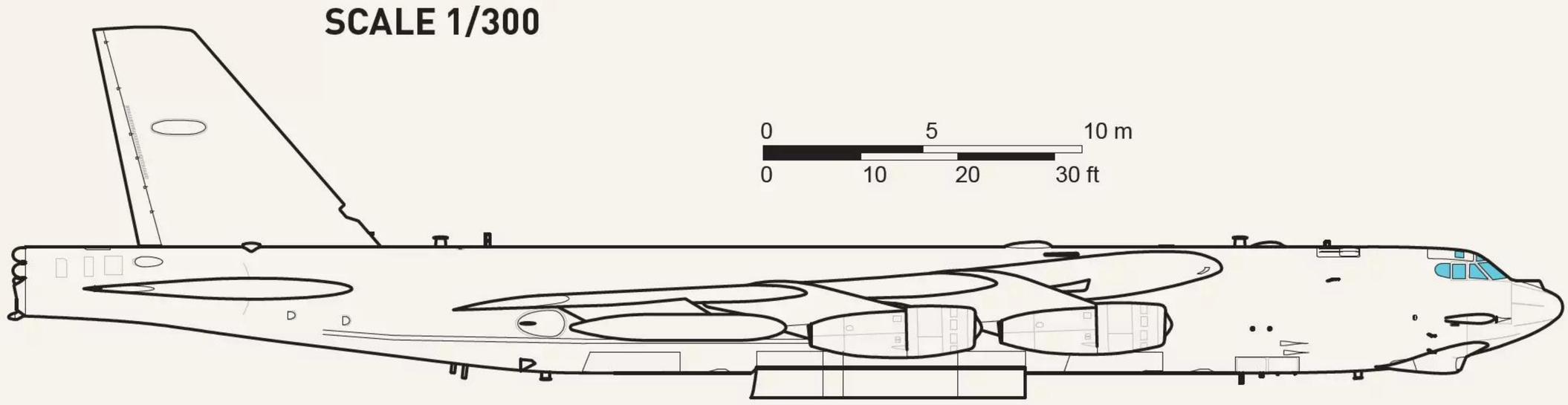

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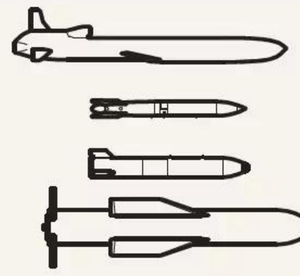

AGM-86B

B-61

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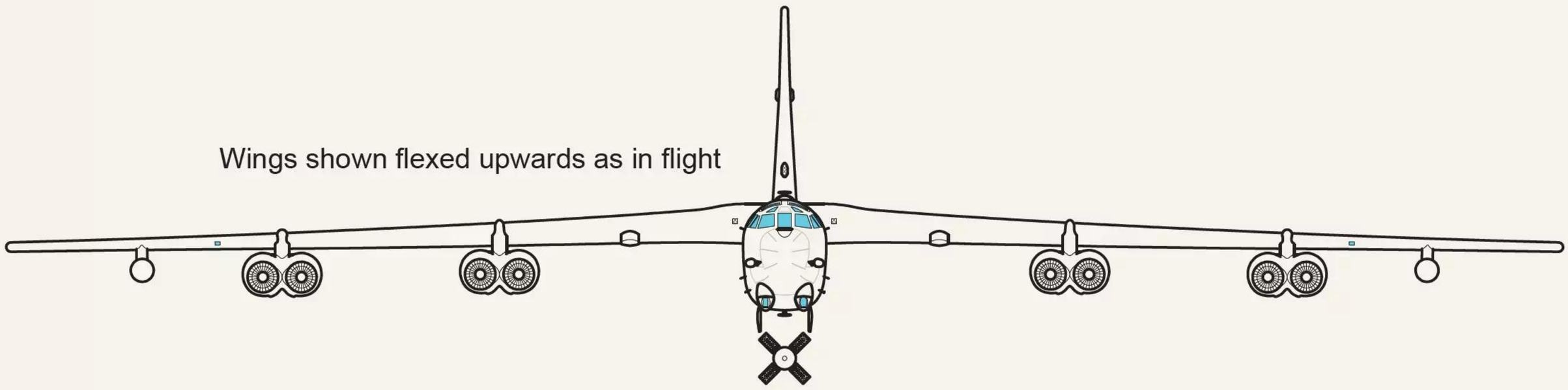
GBU-57 MOP



Wings shown flexed upwards as in flight

Ordnance

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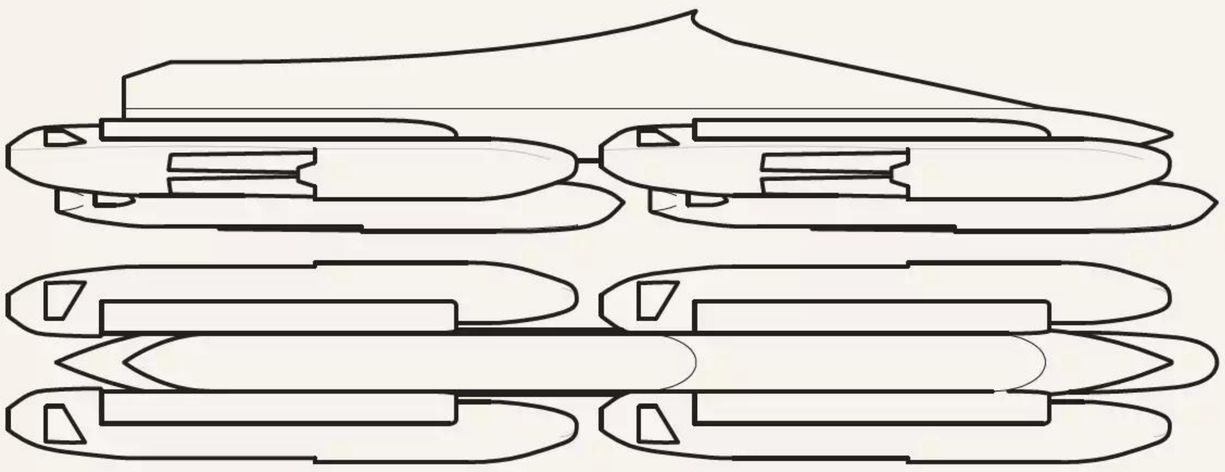
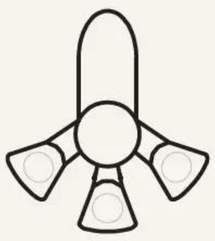
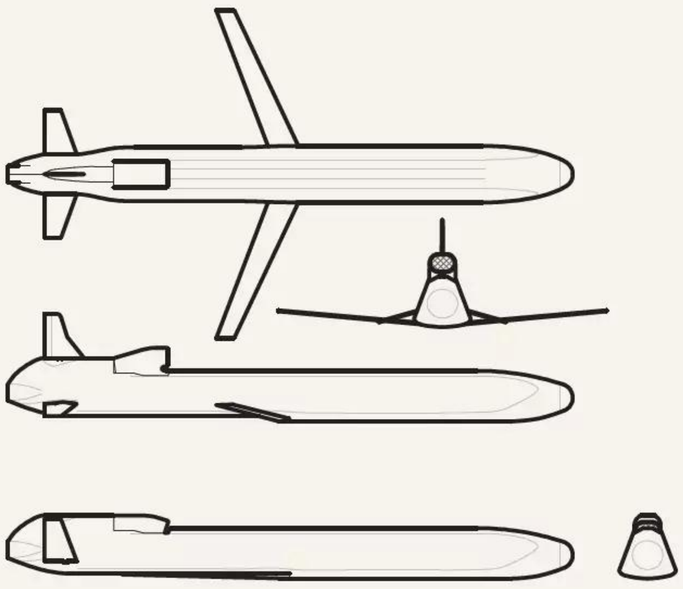
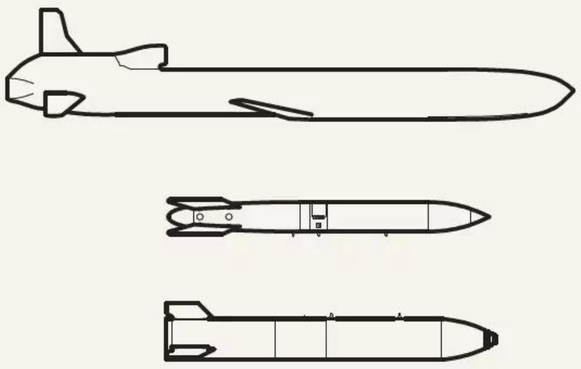




AGM-86C



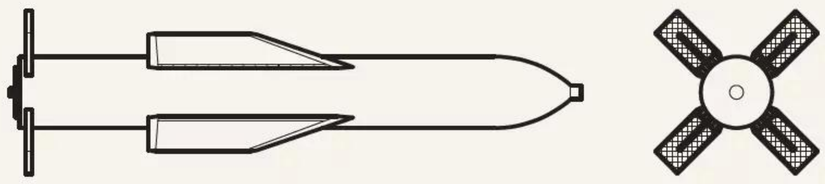


AGM-86B

B-61

B-83

GBU-57 MOP



Boeing B-52J

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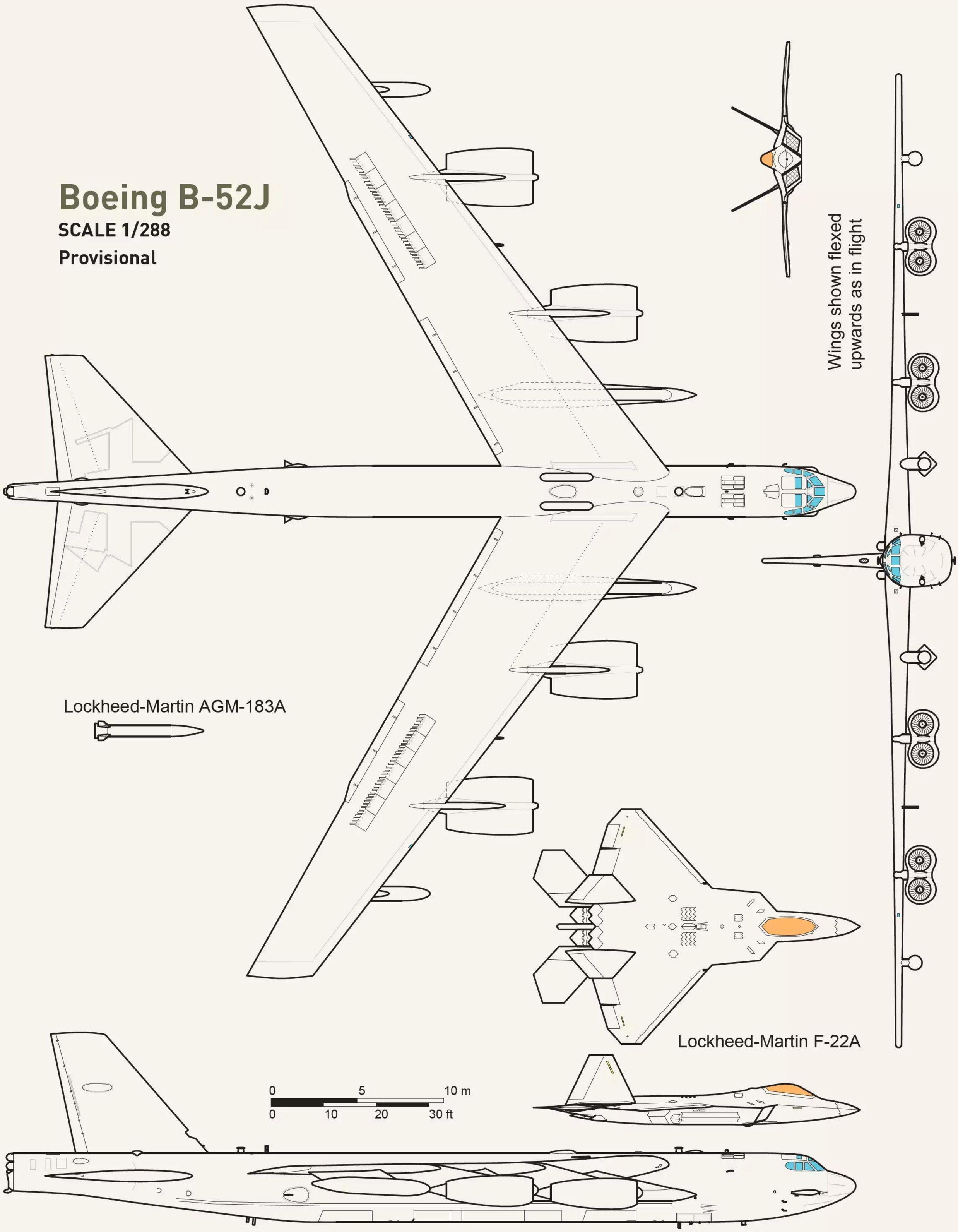
Provisional



right onto them… and it could keep that up for hours, one bomb at a time out of a clear blue – or black – sky.

And then came Operation Iraqi Freedom. Saddam Hussein had worn out his welcome; while he was not involved in the September 11 attacks, nobody wanted to give him the opportunity to be an aggressor again. With contradictory and confused intelligence on whether or not he was working on weapons of mass destruction again, the controversial decision was made to go ahead and make sure that he wasn't by removing him from power. So operations began on March 19, 2003, using a much smaller force of aircraft than had been deployed more than a decade earlier. Nevertheless, the combination of B-52s, B-1s and B-2s, together with strike fighters of various breeds, gradually erased the Iraqi military. The war was officially over by mid-April; Saddam was captured in December. While counter-insurgency operations continued for years, the bomber's role was over relatively quickly in Iraq.

Not so in Afghanistan. There were few massed troop concentrations, no columns of armour, no major industrial infrastructure to turn into splinters and gravel. But there were targets aplenty in a war that dragged on far too many years (culminating with Afghanistan falling to the Taliban again, negating two decades of effort, expense and death). The B-52 was used in fits and starts throughout the nearly 20-year conflict, with sorties right up to the end.

Boeing B-52J

After more than half a century, the B-52 is finally due for a major overhaul. After many years of studying re-engining the B-52H with newer, more efficient engines, a formal contest was initiated in 2018 to provide the B-52 with new engines from the commercial world. Rolls-Royce, General Electric and Pratt & Whitney all put forward proposals for new engines for the B-52. Boeing wind tunnel tested modified B-52 models to study the effects of new nacelles and other aerodynamic changes.

In September 2021, Rolls-Royce was selected to provide the B-52 with 650 new engines in the form of the F130, manufactured in Indianapolis, Indiana. These engines are much more fuel efficient than the legacy Pratt & Whitney TF33 turbofans. The F130 is not a new engine, being derived from turbofans designed for commercial use. While this means they're not bleeding-edge tech they are reliable, well-known and have an existing logistics chain for maintenance. Fuel consumption will be something like 40% lower than the TF33; this will be used to greatly extend the range and/or endurance of the B-52J. As the B-52 has of course been long capable of inflight refuelling the range extension does not immediately seem like a big deal, but by increasing the unrefuelled range the need for inflight refuelling, with all the attendant costs, will be reduced. Rolls-Royce claims that the F130 engine will be so reliable that the typical engine will not need to be removed from the aircraft for maintenance during the expected remaining lifetime of the aircraft. While the F130 may indeed be incredibly resilient, it remains to be seen if it can outlast the B-52. At some point the B-52 may be re-engined again with impulse engines or warp drive.

The re-engining of 76 B-52H aircraft into B-52Js will include more than merely swapping engines. The nacelles and pylons will be replaced; the new nacelles will have full-length bypass ducts and will be somewhat larger in diameter than previously. They will be raised upwards to provide improved ground clearance. Many other improvements will be made to the B-52J. The large blisters under the nose housing the forward looking infra-red and low light cameras will be removed and the nose made more aerodynamic. This change was driven in part by a change in mission; the B-52J it to be much more of a cruise missile truck rather than a low-level bomber; additionally sensor technology has advanced substantially and such large cameras and housings are no longer needed. FLIR and low light cameras will still be available, but housed in underwing pylons when needed. As of this writing Boeing has released a single rendering of a B-52J, along with views of a wind tunnel model; the reconstructed diagram here is therefore somewhat provisional. Further changes include the addition of two sizable hump above the wing shoulders; while undefined and undescribed, these are likely advanced satellite communications systems.

The B-52J continues the USAF practice of non-sequential designations, having skipped right over the 'B-52I'. This was not arbitrary, however; the letter 'I' is often skipped due to its visual similarity to the number '1'. By going to the 'J', there is less chance of the re-engined B-52 being mixed up with the new B-21 'Raider'.

3 CHAPTER B-52 Projects

Boeing Models 464-72 and 464-74

The B-52 began as a turboprop-powered bomber but evolved into a turbojet-propelled design before the configuration was finalized. Turbojet engines had overtaken turboprops for well and good, it had seemed. But even after the Model 464-67 had settled the design, there were some in the Air Force as late as April 1950 who felt that turboprops were still worth considering for the future. B-52s, it was felt, could be retrofitted with turboprops; they would be slower, but range would be increased.

Either as a response to Air Force interest or from sheer cussedness, Boeing designers created Models 464-72 and 464-74 in February 1950, using the airframe of the Model 464-67/XB-52 married to turboprop engines. Both configurations had four turboprop engines derived from the Pratt & Whitney JT 3A turbojets, but utilized them differently.

The configuration of 464-72 was very similar to that of the B-47 derived Model 450-30-10 (designed at the same time; it's probable that the concepts were produced side by side) with engines mounted ahead of the wings in long, slim nacelles that terminated in pusher propellers. The engines were connected by a drive shaft that ran aft to 15ft diameter four-bladed supersonic propellers. These would have had all the problems described for the XB-47D and related designs using supersonic propellers… damage to nearby aircraft structures as well as converting ground crews brains to Silly Putty.

Model 464-74 used the same engines and basically the same propellers, but used them as tractors rather than pushers. Again, the engines were mounted ahead of the wings, now connected almost directly to the propellers. The nacelles were mounted to the wing leading edge and the prop spinners doubled as the engine air inlets. Both Models 464-72 and 464-74 had exhaust nozzles on the upper surface of the nacelles. Each also had four 'slipper' tanks projecting forward from the outer wings.

No performance data is available for either design. It may be assumed that maximum speed was less than that of the jet-equipped B-52, while range ought to have been greater. But since inflight refuelling quickly became routine for the B-52, the added range provided by turboprops would seem to have been a little superfluous while the reduction in top speed could have made the aircraft much more vulnerable.

Extended wings

Just as Boeing studied extended wings and floating wingtips for the B-47, these were also studied for the B-52. Several of the resulting designs are unsurprisingly very similar to their B-47 counterparts. In November 1949 the Bombardment Branch of the Engineering Division at Wright Field requested that Boeing study floating wingtip tanks as a means of extending the range of the B-52, then falling somewhat short. Boeing did so, and seems to have thrown the B-47 into the mix.

Boeing Model 464-79-0

A design known from a single drawing and some data, Boeing Model 464-79-0 was a modification of Model 464-67 (complete with the originally intended tandem cockpit of the XB-52) with floating wingtips. The wing was impressive, with a span 60ft greater than that of the standard B-52. There was a hinge roughly 64.5ft out from the centreline on either wing (about 5ft was chopped off the original wingtips) and 35ft wingtip extensions were added. This outer wing panel was free to 'float' on the hinge, flapping up or down 35°. This would have granted Model 464-79 the same aerodynamic benefits described for Model 450-36-10.

While the B-52 had a single external fuel tank on each wing outboard of the furthest engine nacelles, Model 464-79-0 had two such tanks, one on either side of the hinge line. The tanks furthest out were substantially larger than the inboard tanks and were fitted with horizontal stabilizers at their tails, with an area of 73.5sq ft each. Model 464-79-0 had the B-52 fuselage landing gear as well as similar 'outrigger' stabilizing gear just inboard of the smaller inboard external fuel tank. But it also had dual-wheel landing gear integrated into the outboard fuel tanks to keep them off the ground.

Boeing Model 464-149

Model 464-149 was seemingly Model 464-79 but with a permanently fixed outer wing panel. The wing was simply extended to a span of 230ft. The new outer wing was not attached at the same line as the hinge on the 464-79, parallel to the direction of motion; instead the wing was cut at an angle and the new extension spliced on. Obviously, the intention almost certainly was that the wing would be built that way from the ground up rather

Boeing Model 464-72

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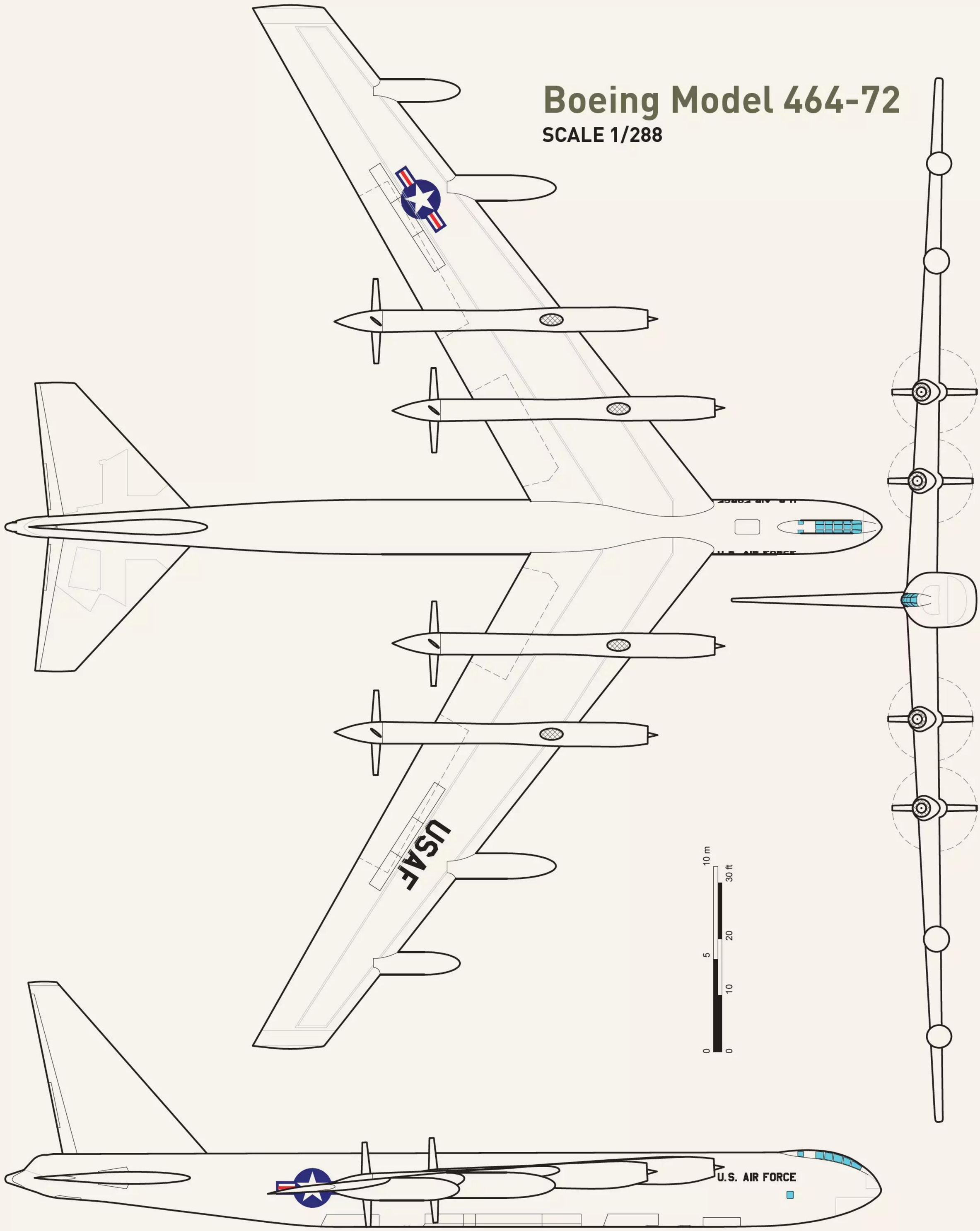

Boeing Model 464-74

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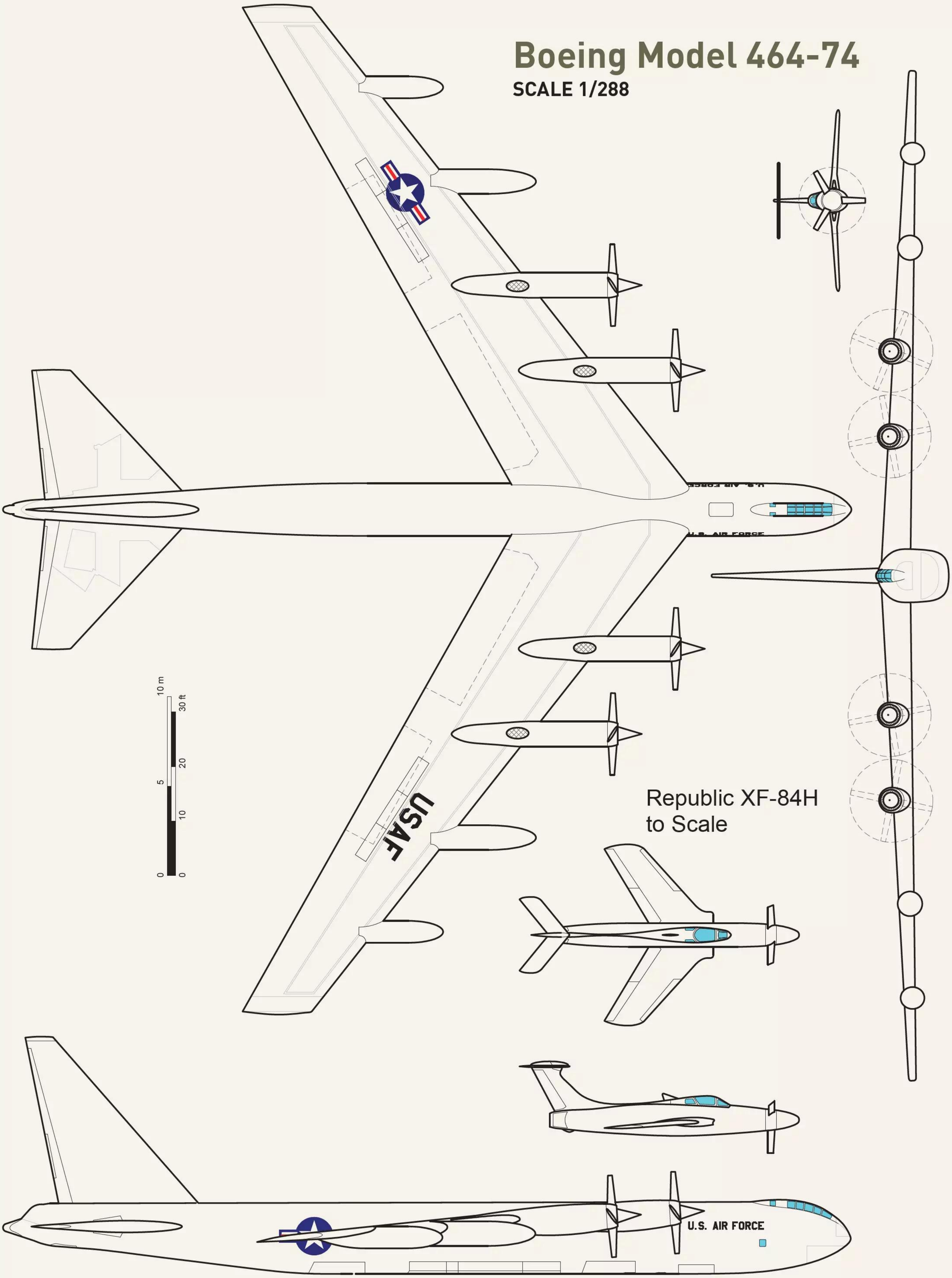

Boeing Model 464-79-0

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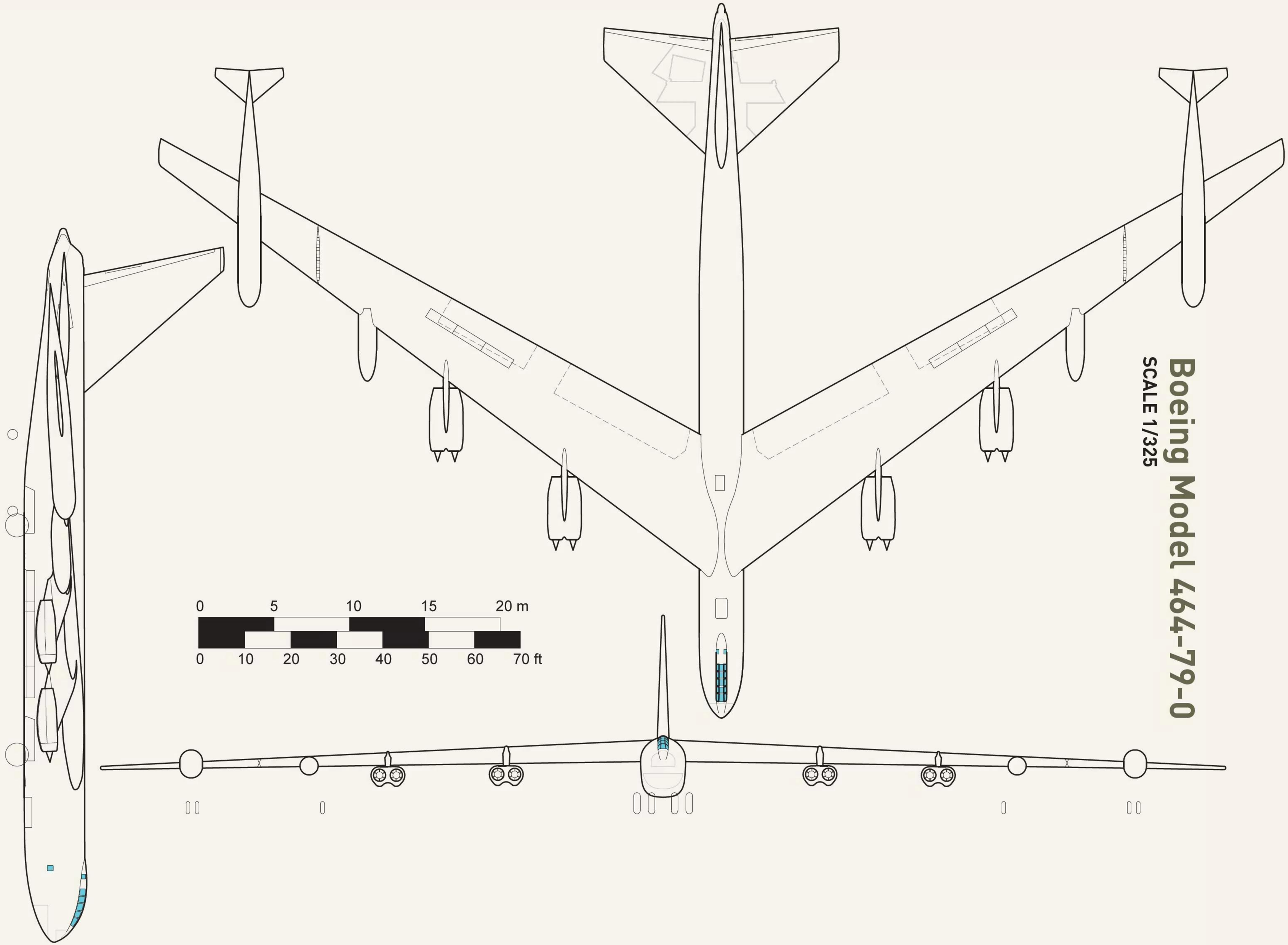
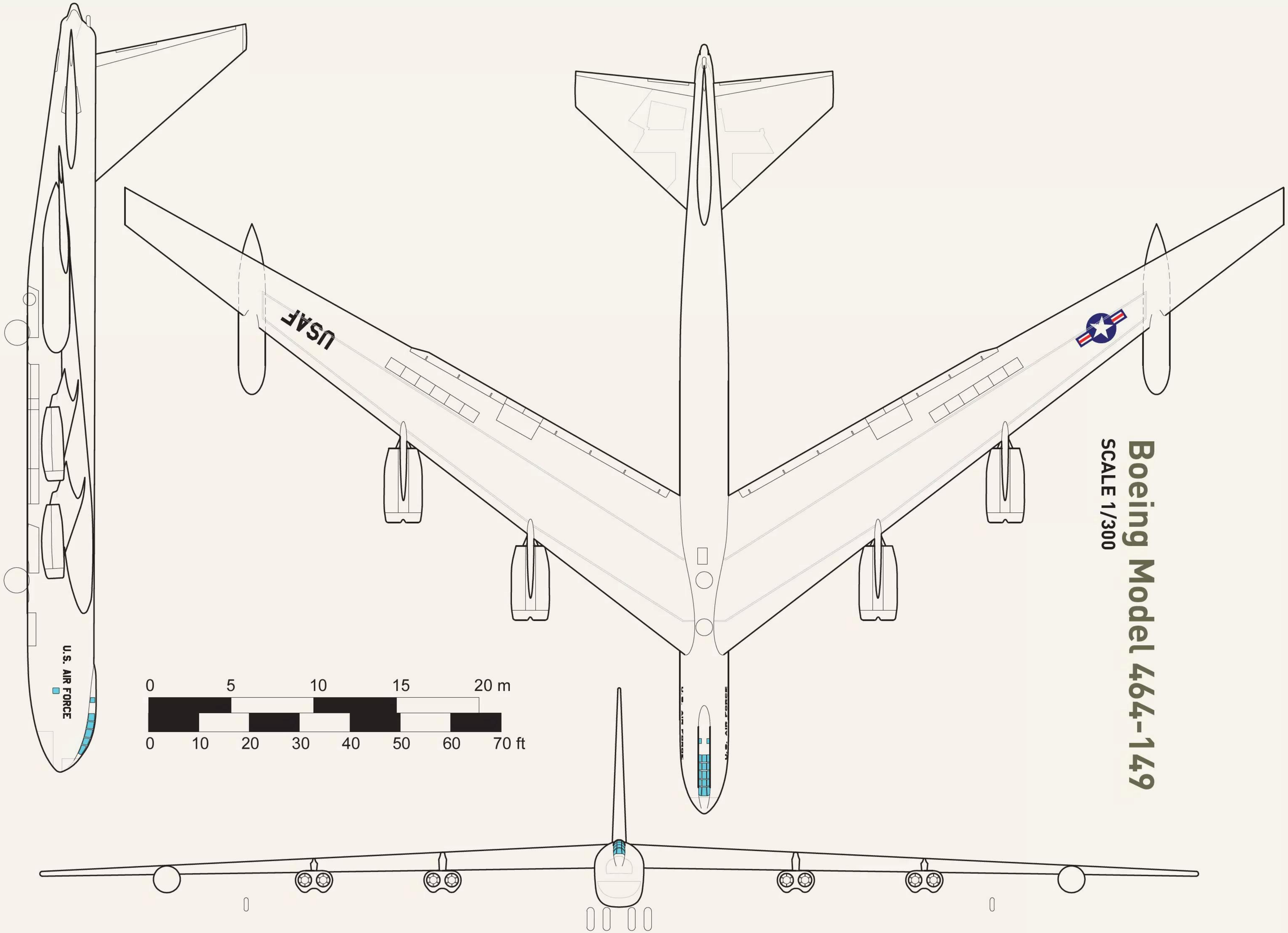


Boeing Model 464-149

SCALE 1/300



than a shorter wing being surgically altered; a modified wing would always be heavier and more structurally suspect than one built correctly the first time.

Gone were the two differently sized external fuel tanks; now there was only a single mid-sized tank permanently affixed to the underside of the outer wing. The normal B-52 outrigger gear was used for ground stability and to keep the nearby external fuel tanks from contacting the runway. No performance data is available.

Boeing Model 464-EXT 1 and 464-EXT 2

Two designs known only from general arrangement diagrams are Model 464-EXT 1 and Model 464-EXT 2 – slight modifications on the theme established by Model 464-149. 464-EXT 1 was very similar to 464-149, but with a somewhat larger external tank under the outer wings, held by a short pylon, rather than integrated into the wing lower surface. The tank came complete with its own two-wheel landing gear to assure a safe ride on the runway. The outrigger gear was deleted.

464-EXT 2 had two somewhat smaller external tanks attached by pylons below the outer wings. These also had their own landing gear. Once again there is no performance data for these designs.

Boeing Model 724-15

Discussion of floating wingtips for the B-52 brings up another Boeing design which used that concept. While not derived in any meaningful way from the B-52, Model 724-15 was a design meant to supplant the B-52; it was Boeing's initial entry into the competition that led to the B-70 Valkyrie Mach 3 bomber.

The USAF had begun to develop a new non-nuclear powered bomber in 1954 as Weapons System 110A. It needed to be able to operate from the continental US and strike targets within the Soviet Union. It needed a minimum cruising speed of Mach 0.9 and a Mach 3 dash for at least 1,000 nautical miles, ideally 2,000 miles.

In July 1955, the USAF held a WS-110A bidders conference (also incorporating the WS-125A nuclear powered bomber studies) at Wright Field; only North American Aviation and Boeing decided to submit WS-110A proposals. Both companies presented their designs to date in mid-1956, and both featured the same gimmick: short-span supersonic bombers, optimized for Mach 3 flight, were married to long, high aspect ratio jettisonable wing panels equipped with large aerodynamic fuel tanks.

Boeing's Model 724-15 of April 1956 was of remarkably similar in layout to its North American competitor. A large supersonic bomber with four engines and highly swept rather short-span wings was equipped with two long-span wing extensions, each with its own fuel tank. The wings themselves were also full of fuel, giving the bomber an extra 22,400 gallons of fuel per wingtip for takeoff and long-range subsonic cruise as well as triple its own basic wing area.

When the time came for high-speed dash, the wing panels would be simply jettisoned, leaving a clean high-speed configuration capable of triple-sonic flight. The jettisonable wingtips – similar in concept to those used on the Boeing Model 464-79-0 – had their own model number, 724-1003, and were large structures in their own right, about two-thirds the size of a B-47.

Model 724-15 had a cockpit canopy somewhat similar to that of the final B-70 in that a fairing would tilt up or down to present either a smooth low-drag surface or improved forward vision for takeoff and landing. The nose as a whole was fixed, unlike the drooping noses of most supersonic transports.

As with the North American design, 724-15 was a clumsy solution to the problem. It required runways that were not only long but also incredibly wide; the span from centreline to centreline across the fuel pods was 172ft. Runways would have needed to be around 200ft wide. Additionally, in order for aircraft to simply practice at supersonic speeds, the large and expensive jettisonable wingtips would have had to be expended every time.

The baseline payload was a single undefined 10,000lb 'special' weapon – a large hydrogen bomb. Other weapons loads were considered, including a single 25,000lb hydrogen bomb. During a standard mission, Model 724-15 would cruise at 460 knots for 1960 nautical miles at an altitude of 32,100-36,100ft. It would then jettison the wingtips and begins its dash, cruising at 1725 knots while ascending to 63,100ft. After dropping its weapon it would turn around and fly another 1,070 miles at 1,725 knots while climbing to 67,600ft. Then it would descend to 37,800ft and slow to 518 knots for the subsonic cruise home.

As with the North American submission, the Boeing design was rejected outright. General Curtis LeMay considered the designs to be more like three-ship formations than proper aircraft. As a result, both North American and Boeing went back to the drawing board.

Boeing Models 464-238 and 464-239

Another way to improve the B-52's range performance was to simply scale up the wings. This was the aim of Models 464-238 and 464-239, known to this author solely through two top-view diagrams dated April 1954. The 464-238 had a wing scaled up to a span of 218ft and a wing area of 5,600sq ft; otherwise the fuselage design seems to have been largely unchanged from the B-52A. The engines were changed to Wright J67s.

Model 464-239 had a wing of the usual 185ft span, but the chord was widen to increase wing area. The standard B-52 had a theoretical chord of 30ft 11in at the centreline;

Boeing Model 464-EXT #1

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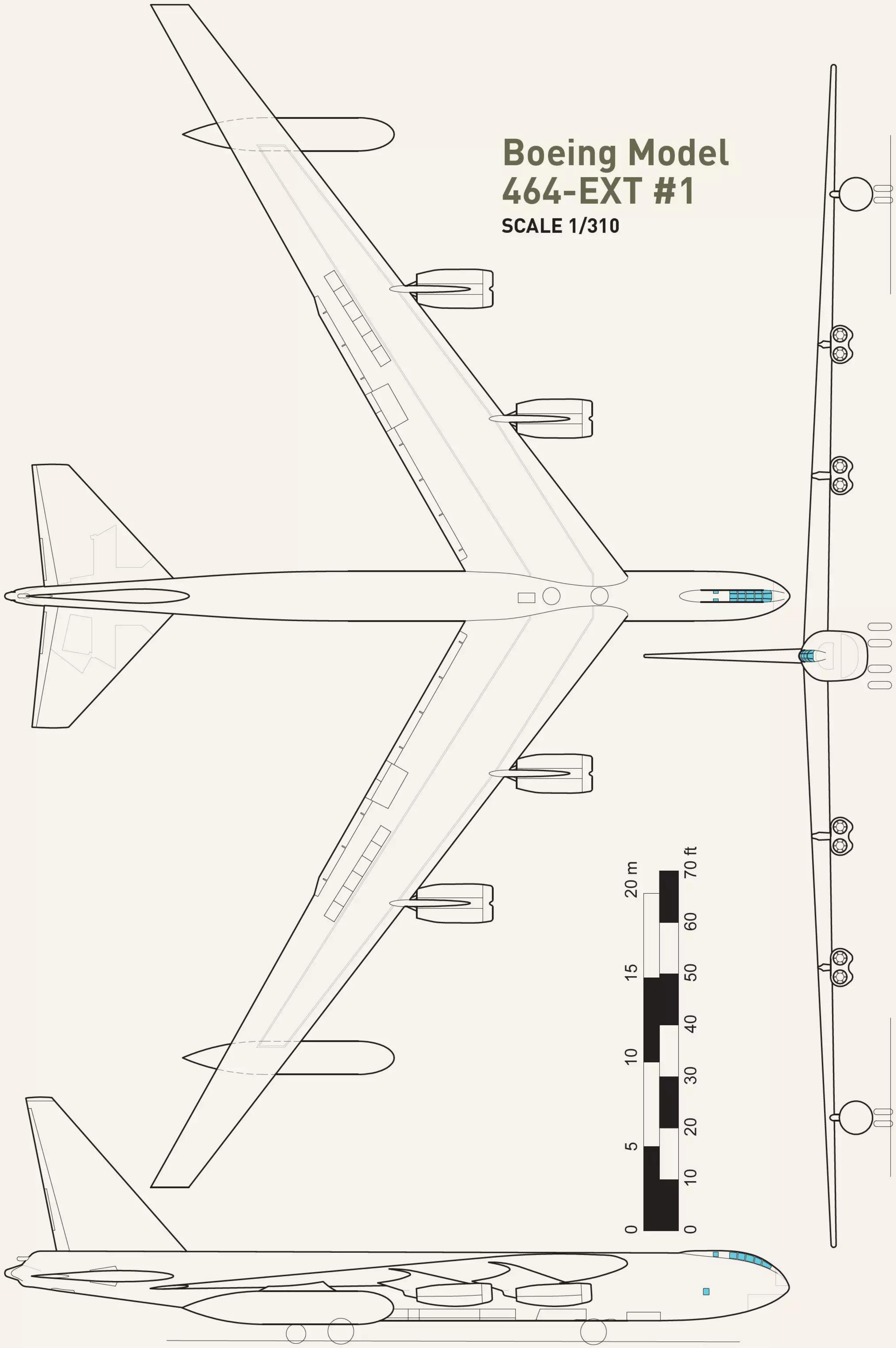
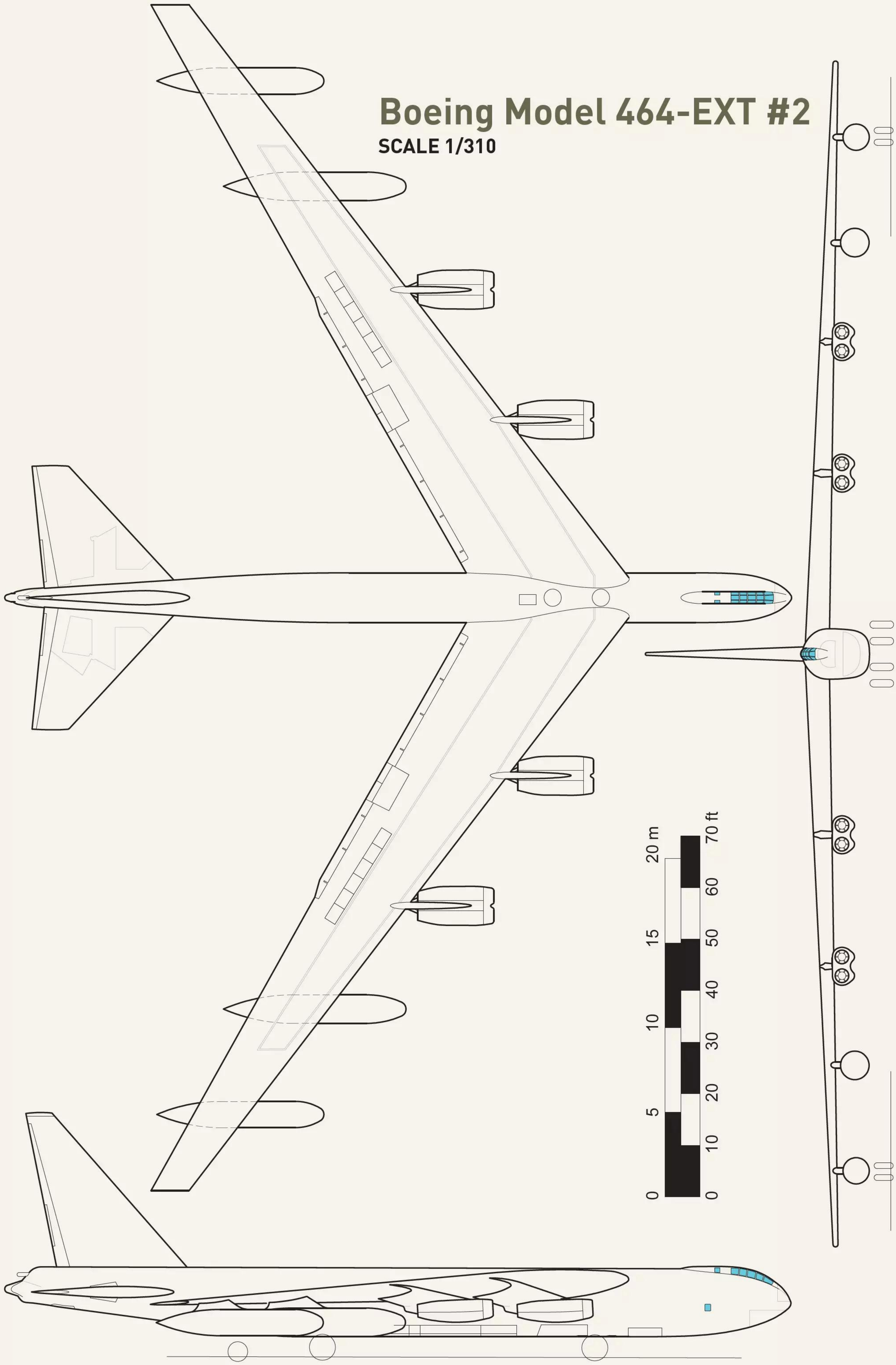


Boeing Model 464-EXT #2

SCALE 1/310



the Model 464-238 was 36ft 6.7in and the Model 464-239 was 37ft 1.2in. No further data is available.

Boeing Model 713

Boeing used the Model 713 designation as a catch-all for advanced bomber concepts. Dozens of designs were included, beginning in June of 1954; many were supersonic, many were nuclear powered, and more than a few were both. Those designs fall outside the scope of this work, but several were clearly inspired by the B-52, if not actually directly derived from it. The configurations of the Model 713-1-133 and 713-1-138 series were much like the B-52… only more so.

Model 713-1-133 came in three variants, A, B and C, all dating from mid-December 1954. They, and the apparently largely identical Model 713-1-138 from February 1955, shared a common wing, fuselage and tail, all reminiscent of the B-52. The cockpit contours and fuselage cross section were very much like those of the B-52. Where 713-1-133 differed from the B-52 was in scale. Its span and length were more than a quarter again as long as the B-52; the wing area was more than doubled. While the nominal bomb load remained 10,000lb, gross weight was far beyond that of the B-52.

The differences between the Model 712-1-133 variations were in the engines. The -133A had 12 or 14 Pratt & Whitney J75 engines (the data says 14; the diagram shows 12), while the -133B had 14 General Electric X-84 engines. The X-84 was an unbuilt turbofan engine design of variable size and performance; various sources list thrust levels of 20,000 to more than 24,000lb of thrust. The 133C was similar to the -138 in that they each had 16 X-84 engines. This would have produced something along the lines of 320,000 to 384,000lb of thrust, compared to the 74,000lb that the early B-52s could produce. This would be a remarkably high power output for a subsonic bomber, producing a thrust to weight ratio of more than 1:2 at gross takeoff weight… and more than 1:1 at empty weight. The -133 series and the -138 had the same weights, but the -138 had an extra 12ft of wingspan and 1,000sq ft of wing area, bring it to a total of 10,000sq ft (929sq m) – vast by any reckoning.

No performance data is available. It can be assumed that range, and probably ceiling, would have been impressive. As nuclear power was common in the other designs in the Model 713 series, it's safe to assume that the 713-1-133 and-138 were meant to show competitive performance from a purely chemical system.

Boeing Model 464-197

Possibly the fastest B-52 derivative concept ever designed, Boeing Model 464-197 is known from a single diagram and some basic data. It was produced for the MX-1965 program which led to the B-59, the same programme that led to the Model 450-65-10 series, Model 450-151-31, Model 450-154-32 and Model 701-333 described in the B-47 chapter. But beyond that, little is known about the 464-197 other than it was a B-52 heavily modified into a supersonic-capable configuration.

The 464-197's fuselage and tail were much like those of a standard B-52B, with the exception of the nose. The relatively blunt nose of the B-52 was replaced with a pointed nosecone and the windscreen was reshaped for lower drag at high speed. The biggest difference was that the long, narrow wings of the B-52 were replaced with entirely new shorter-span, longer-chord wings of about 45° sweep (40° at quarter chord), a thickness ratio of only 4% and substantially greater wing area. The vertical tail was reduced in size somewhat. It retained the main quadricycle landing gear of the standard B-52, with outrigger stabilizing gear deployed from the outboard nacelles. The aircraft still had eight engines in four underslung pods, but the pods were entirely different in shape and size from those of the standard B-52.

While the standard B-52 pods had quite simple inlets, those of the 464-197 had vertical ramps. The engines inside were Wright J67s, which was to be a license-built version of the Rolls-Royce Olympus engines that powered the British Vulcan bomber. But while the Vulcan had four of these afterburning engines, Model 464-197 was to have eight, enough to power the aircraft through the sound barrier. The nacelles were longer than standard B-52 nacelles in order to provide space for the afterburners. The design's performance potential is not available.

It's not clear if Model 464-197 was meant to be an operational bomber for series production or possibly a test aircraft for some of the MX-1965 design concepts. However, it was to have a 10,000lb bomb as standard, with the ability to carry a 50,000lb bomb.

Liquid hydrogen fuel

There was a mid-1950s fascination with liquid hydrogen as an aircraft fuel. The combustion energy contained within a kilogram of hydrogen is approximately three times what's available in jet fuel; this is the sort of advantage that will cause many aircraft designers to try to work around the fact that the density of liquid hydrogen is only one-tenth that of jet fuel, and that to keep hydrogen a liquid it must be stored at dangerously low temperatures. But the 1950s was the great 'can-do' era in American aerospace development, so studying hydrogen was inevitable.

The NACA Lewis Flight Propulsion Laboratory studied the theoretical side of hydrogen propulsion for aircraft and in 1955 showed sketches of several possible configurations. Hydrogen aircraft could in principle use

Boeing Model 724-15

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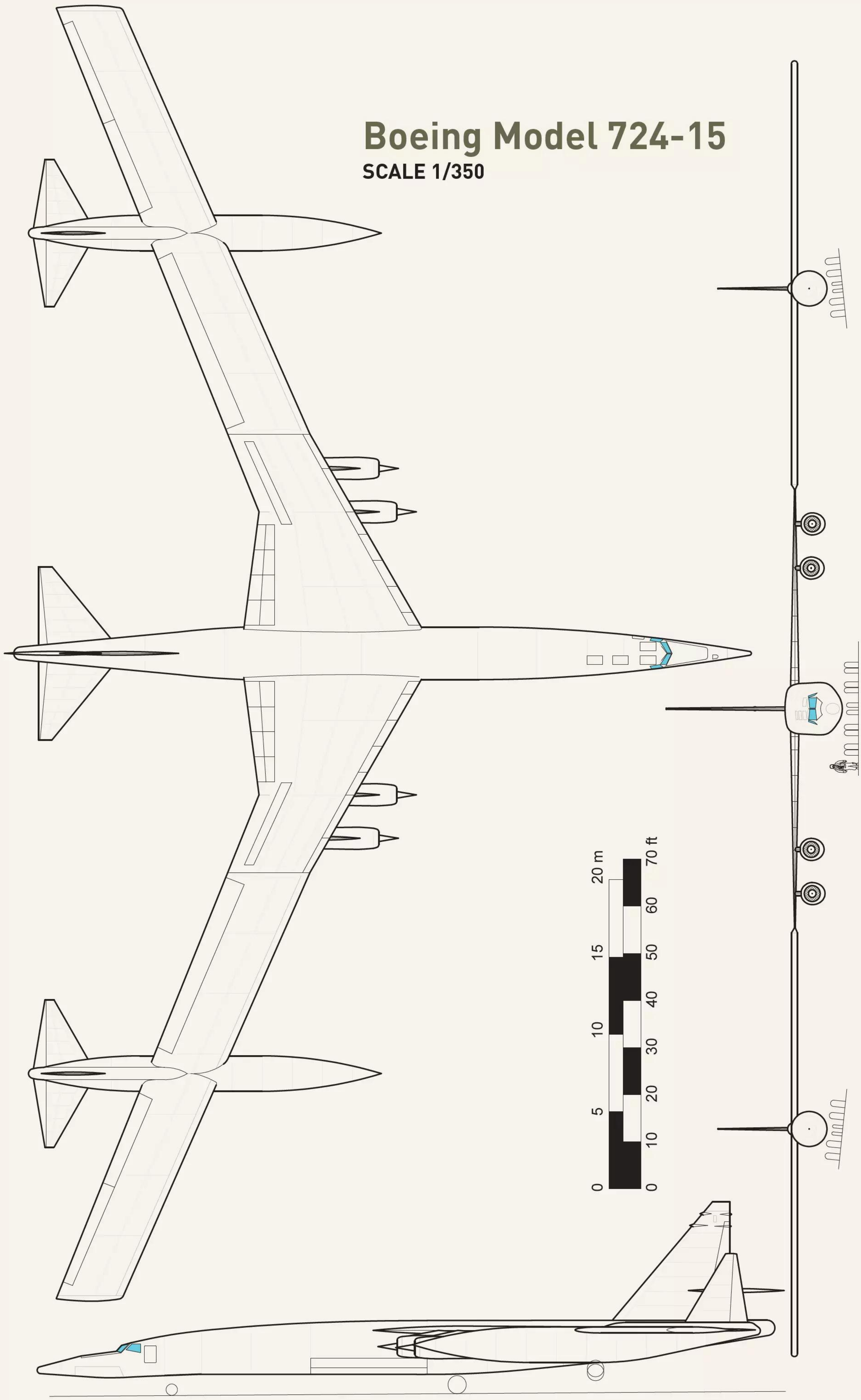

Boeing Model 724-15
Model 464-79-0
Model 450-36-10

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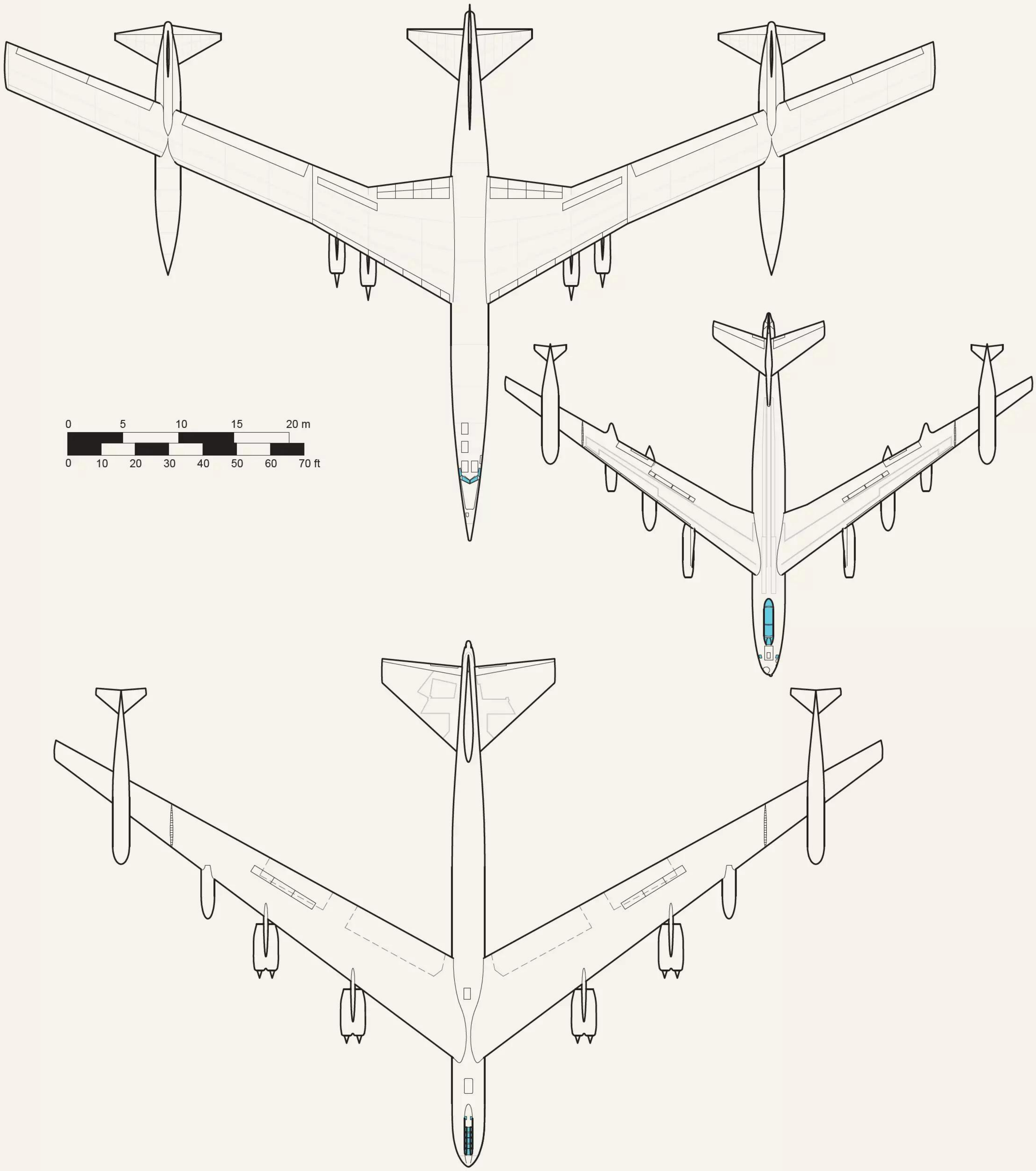

Boeing Model 464-238

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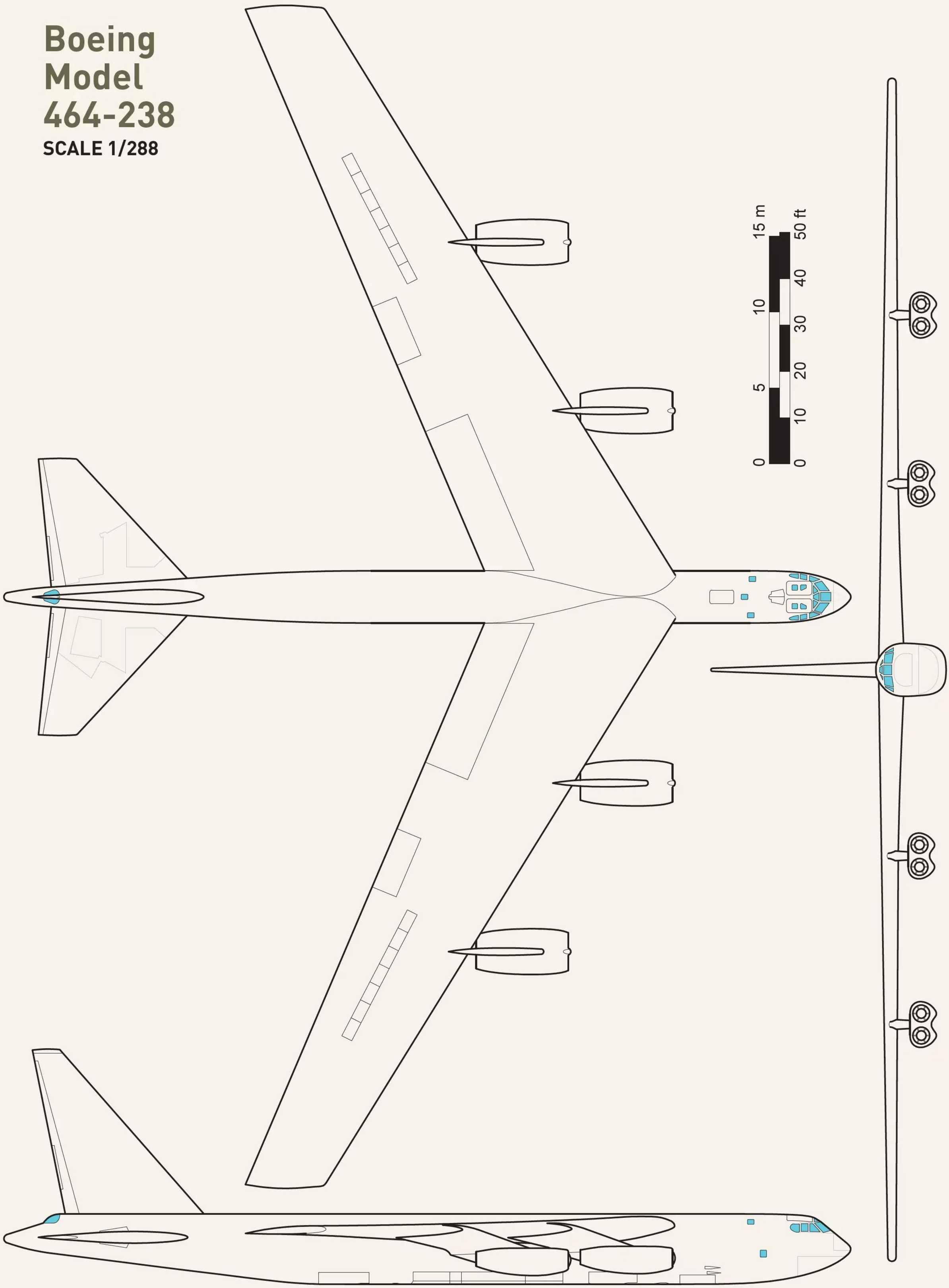

Boeing Model 464-239

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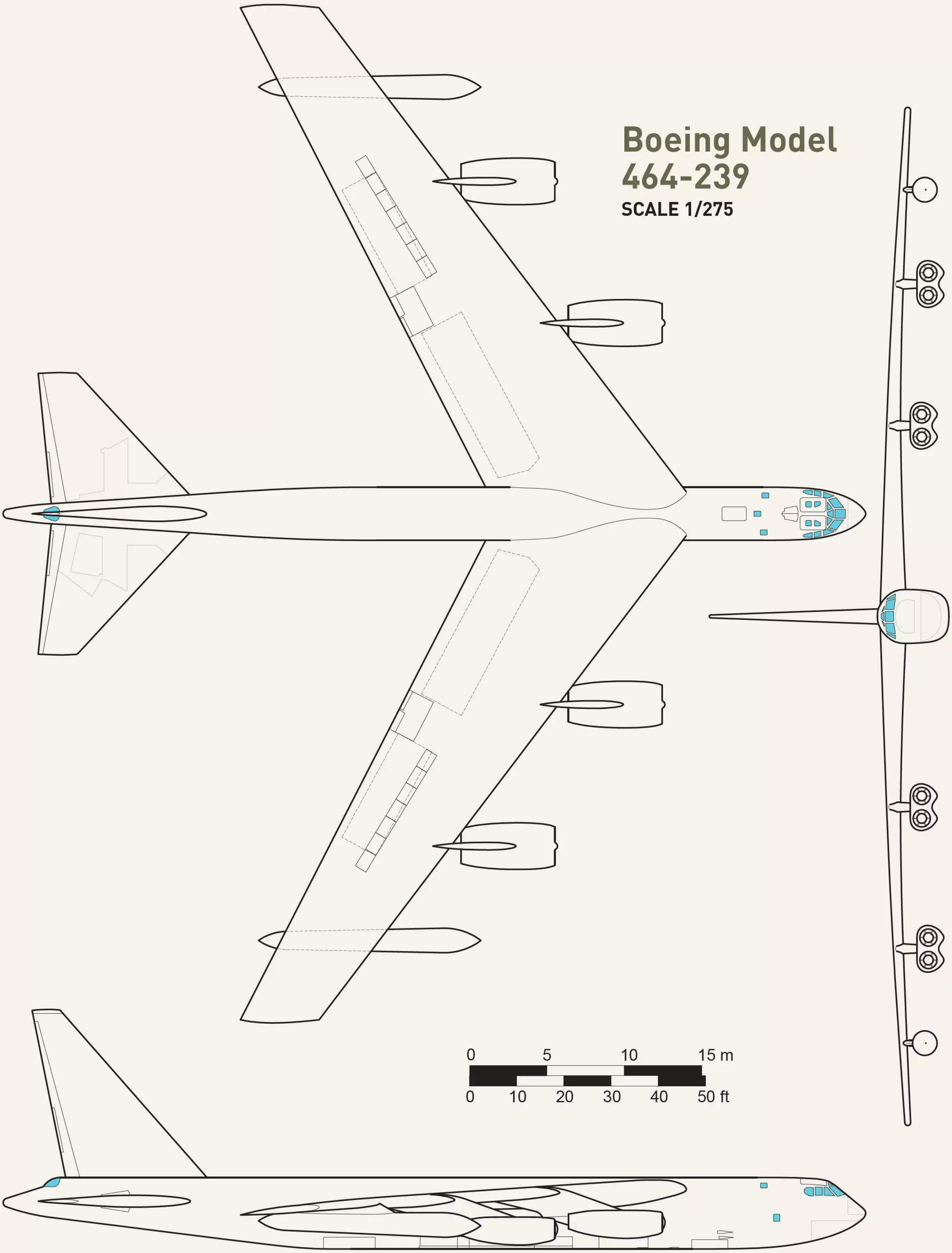

Boeing Model 713-1-133

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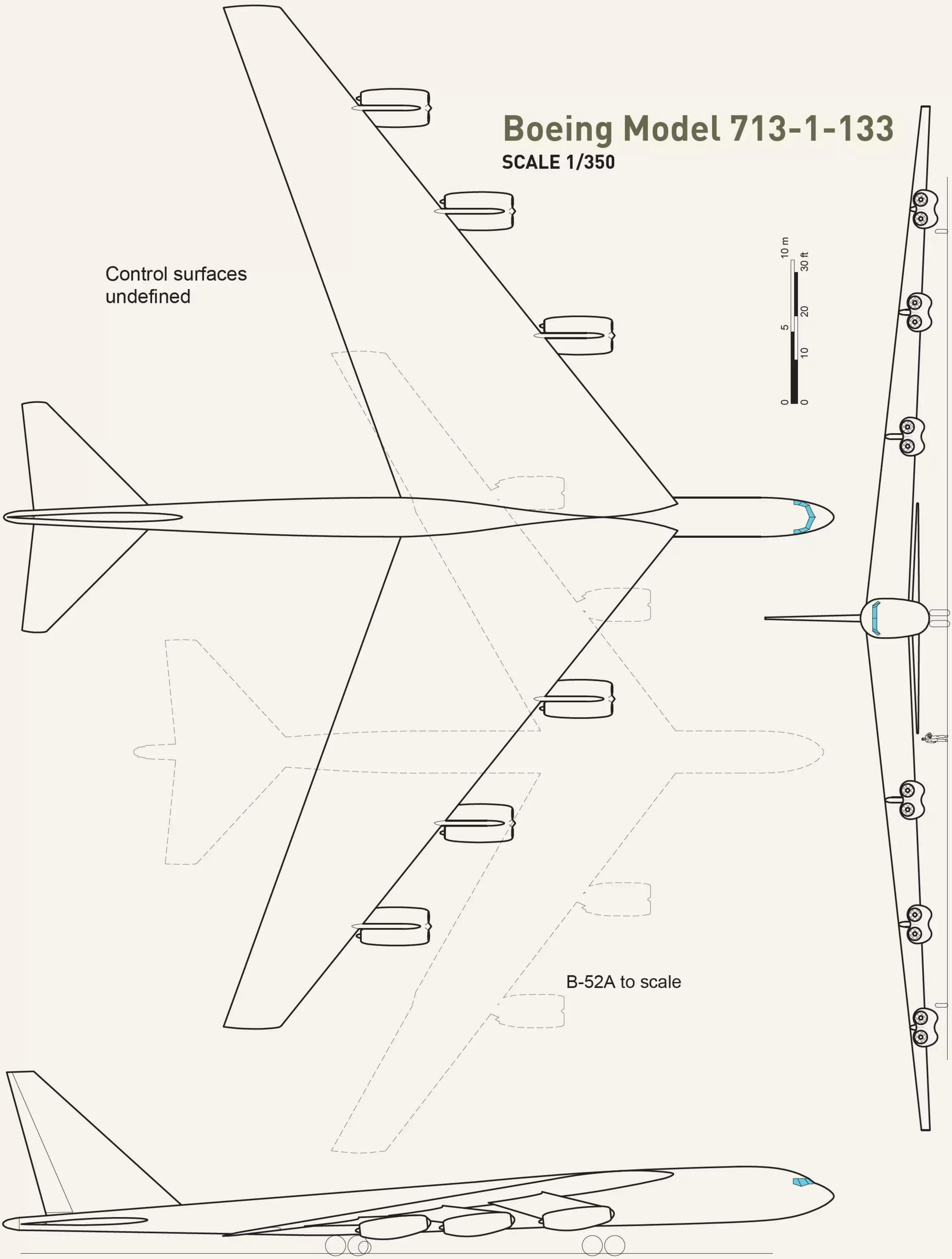
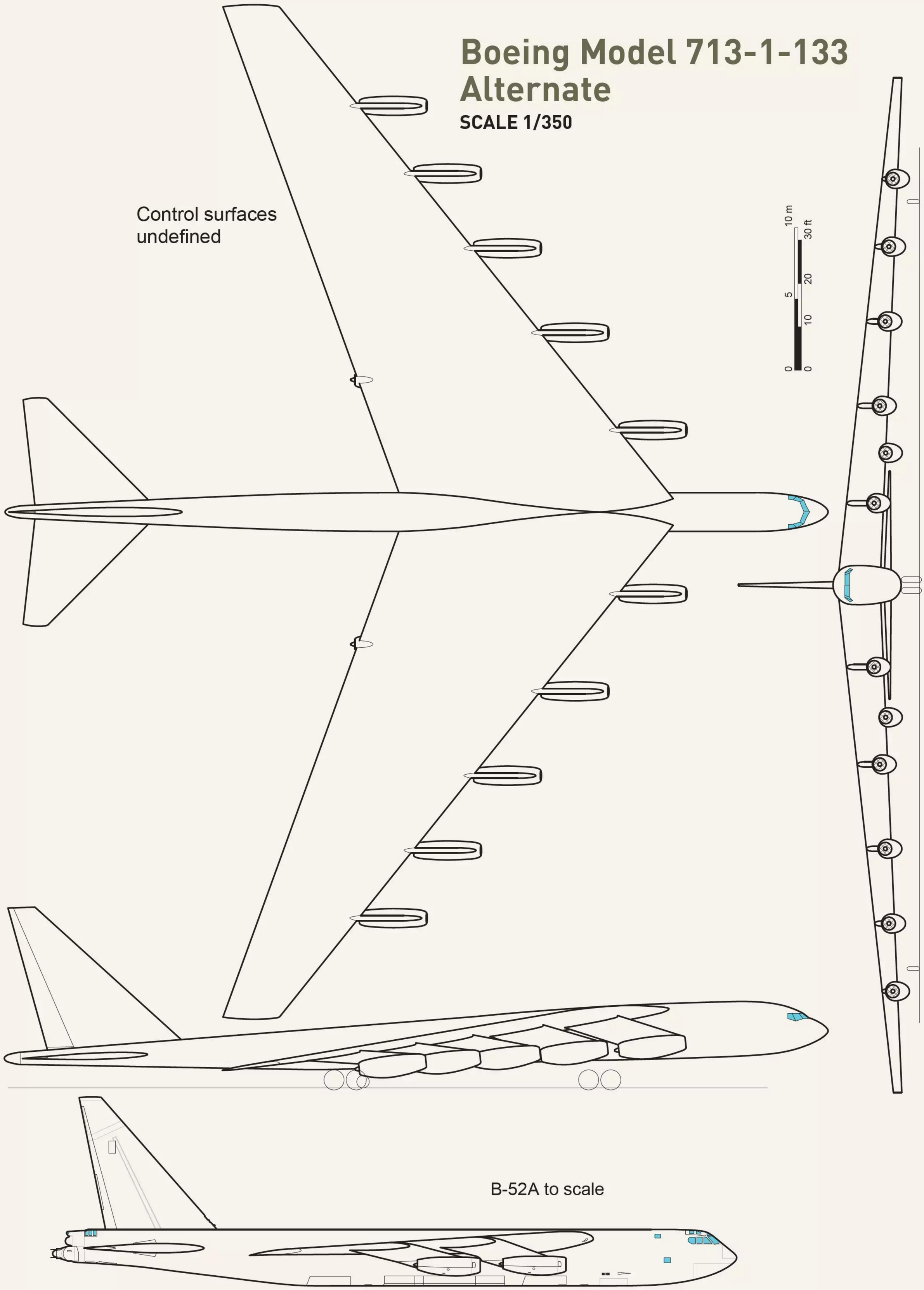


Boeing Model 713-1-133 Alternate

SCALE 1/350

Control surfaces undefined



B-52A to scale

Boeing Model 713-1-133C

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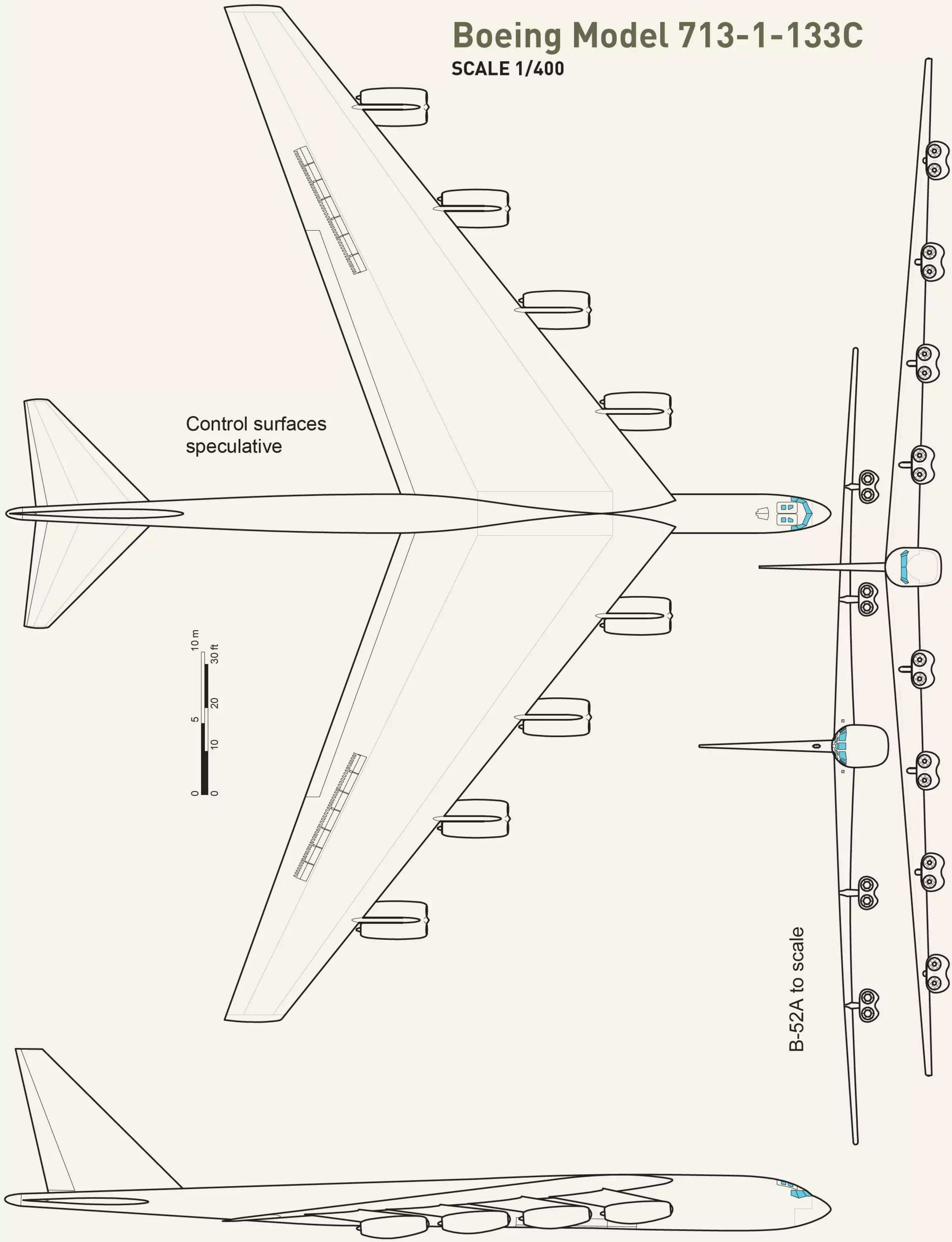

Boeing Model 713-1-138

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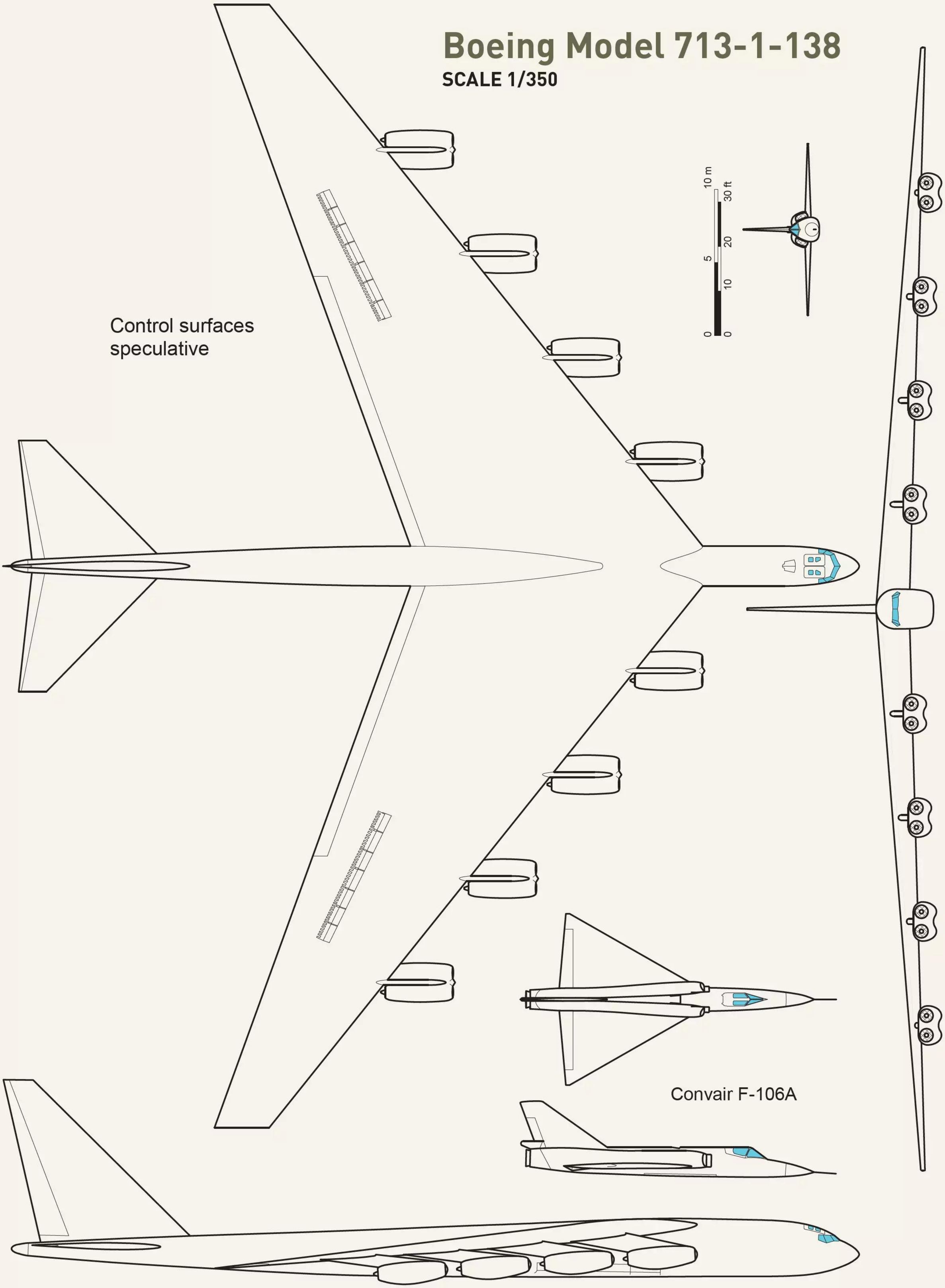

conventional turbojet engines with modest modifications, but the airframes would be distinctive. The low density, cold temperature and high pressure of the propellant meant its tanks would need to be large to the point of being vast.

The aircraft that the NACA-Lewis looked at were mostly supersonic designs with voluminous spindle-shaped fuselages with small wings, but the notion of a subsonic bomber/reconnaissance plane clearly inspired by the B-52 was also kicked around. Powered by four engines, it was laid out like the B-52 with large cylindrical tanks filling the fuselage; but even then there was not enough fuel storage volume. Additional liquid hydrogen was stored in the wings in banks of long and relatively thin cylindrical tanks; lacking volumetric efficiency, these would have made the wings both fat and stiff.

Boeing Models 464-245 and 464-246

At the same time, the American aeronautical industry also looked at hydrogen fuel. The best known of these efforts was Lockheed's CL-400 'Suntan', a Mach 2+ high-altitude reconnaissance plane; a great deal of time and effort was spent on it, producing some important advances… but not a hydrogen powered aircraft. Boeing also studied hydrogen fuelled aircraft of numerous kinds including supersonic bombers and reconnaissance vehicles of entirely new configurations… but hydrogen conversions of the B-52 were also examined. Two such configuration are known: Models 464-245 and 464-246. Performance data is lacking.

Model 464-245 used a largely conventional B-52 wing and fuselage, but added two very large fixed external fuel tanks. These tanks, each roughly the size of the B-52's fuselage, were fitted to the wings in the positions formerly occupied by the inboard engine pylons. The outer pylons still held two engines each, but these were now non-afterburning Pratt & Whitney J75s with modifications to burn both jet fuel and hydrogen. The J75 could produce something like 70% more thrust than the contemporary J57, so the dropoff in thrust was not that great.

Each of the giant wing pods would contain 41,500lb of liquid hydrogen and there would be additional hydrogen tankage in the fuselage. The wing tanks were still to be filled with jet fuel, totalling 134,000lb. Exactly how the aircraft would use both fuels is unclear. It's interesting that the wing tanks still managed to hold a much greater mass of jet fuel than the giant hydrogen tanks.

Model 464-246 was obviously designed at the same time. This design dispensed with the large external tanks in favor of a redesigned and much larger fuselage. The new fuselage was circular in cross section, about 17 or 18ft in diameter, with six separate fuel cells holding a total of 89,500lb of liquid hydrogen. The wing tanks would hold 152,000lb of JP-4 fuel. This aircraft had six J75 engines, two in inboard nacelles, and single engines in outboard nacelles. This aircraft would have required substantially more modification than Model 464-245, but it would have been a more aerodynamic vehicle.

Nothing seems to have come from Boeing's brief foray into modifying the B-52 for hydrogen fuel. The difficulties associated with liquid hydrogen have kept it from being an aviation fuel for nearly 70 years. Future issues with hydrocarbon fuels may lead to hydrogen fuelled aircraft which may resemble Model 464-245 or 464-246, but it is very unlikely that a B-52 will be retrofitted in this manner.

Inflight refuelling

This process was introduced to the B-52 design evolution with Model 464-33 in January 1948 and while it promised greatly increasing range, there was also a major problem: the tanker aircraft. The first tanker aircraft to enter US Air Force service, in 1951, was the capable but limited KC-97 Stratofreighter. Derived from the B-29, it was powered by piston engines and flew slowly – so slowly in fact that B-52s attempting to rendezvous with it generally had to not only deploy flaps but also lower their landing gear in order to match its speed. This of course was not optimal.

Boeing Model 491

The inflight refuelling problem was foreseen early on; a faster, higher-flying tanker was needed and would eventually appear in the form of the KC-135, which did not fly until 1956.

Back in 1949, the KC-135 was well beyond the horizon. But the B-52 had already become a fully jet-propelled design by that point and a piston-engined tanker simply wasn't going to be adequate. So in December of 1949, Boeing designed Model 491.

Unlike the KC-97 and the later KC-135, Model 491 was an entirely new clean-sheet concept. It was a twin-boom design with a central truncated fuselage, not unlike the Lockheed P-38. Equipped with six Allison T40 turboprops, each with an eight-bladed contra-rotating propeller of 15ft diameter, it could reach 490mph at 25,000ft. Coupled with this speed, about 115mph faster than the KC-97G, Model 491 could carry 39,000 gallons (or 40,000 gallons – see below) of fuel… some 30,000 gallons more than the KC-97. Model 491 could fly high and fast enough to comfortably refuel the B-52.

A single flying boom taken from the KC-97 was attached to the right-hand boom. The boom operator was located in the central fuselage pod, rather than the boom.

Not much information is available on Model 491, indicating that it was probably not deeply studied or seriously proposed. But it does show that Boeing understood that the B-52 would need a new tanker aircraft even before it flew.

Boeing Model 464-197

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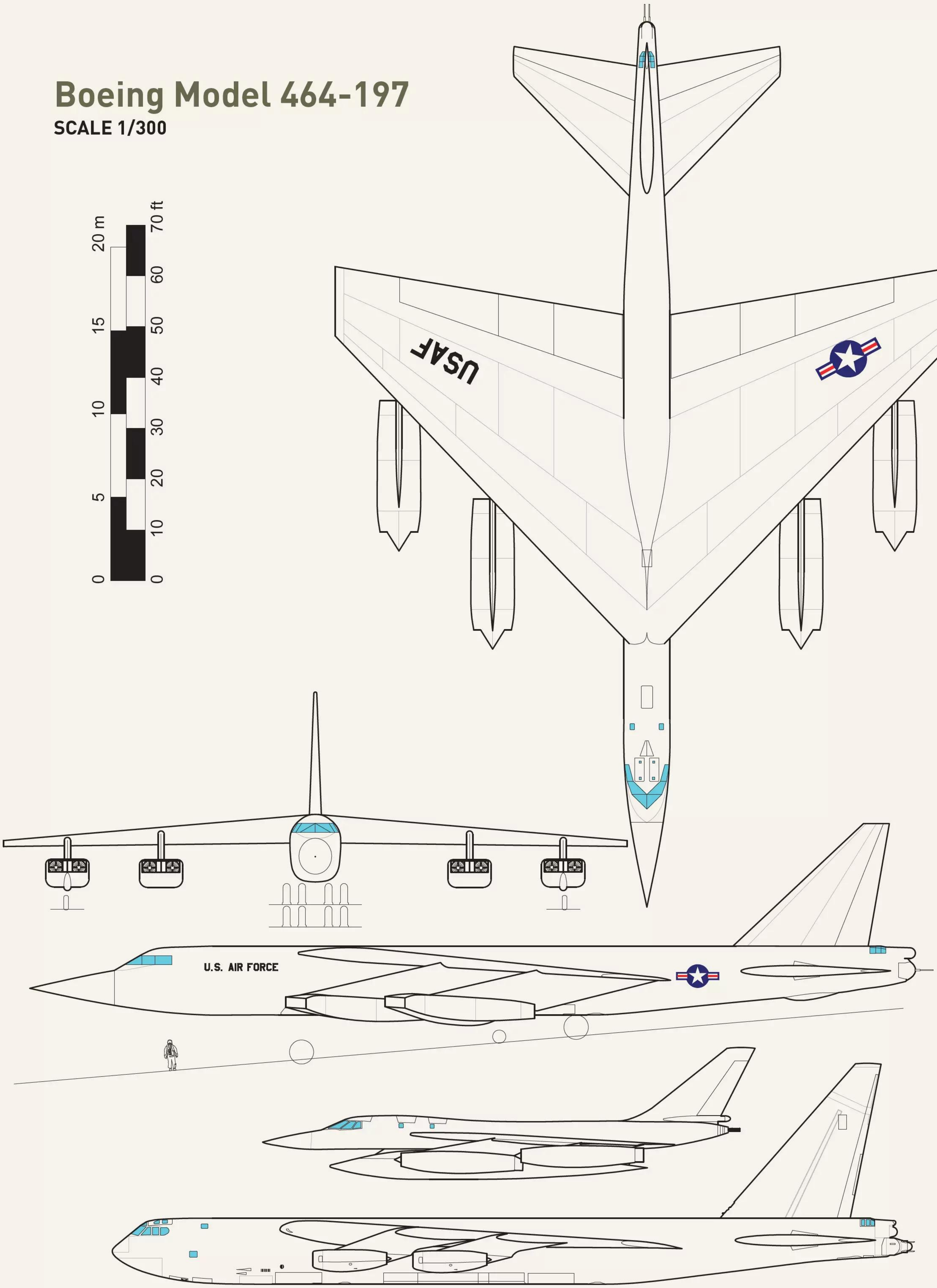

Boeing Model 464-197

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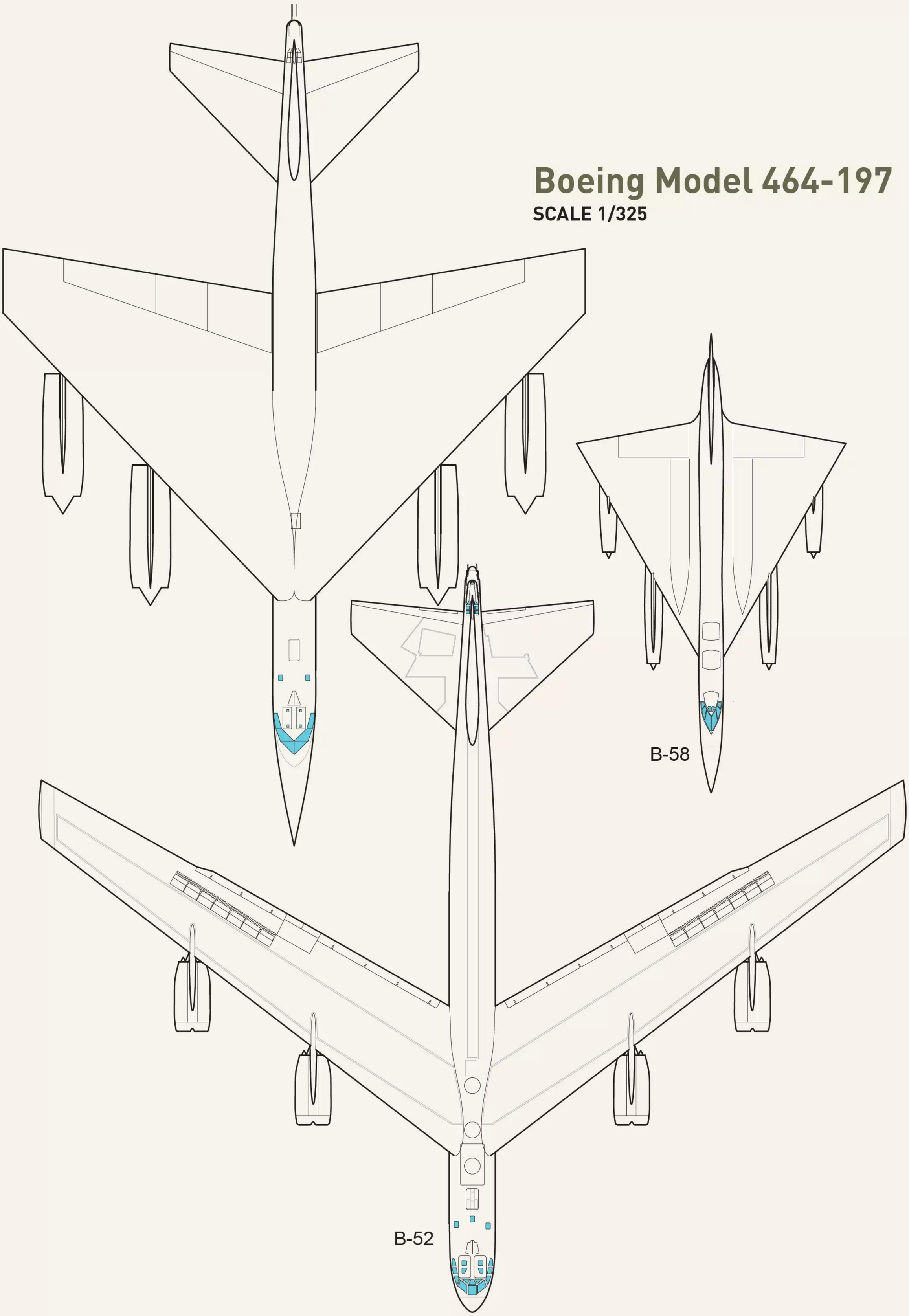

Boeing Model 464-245

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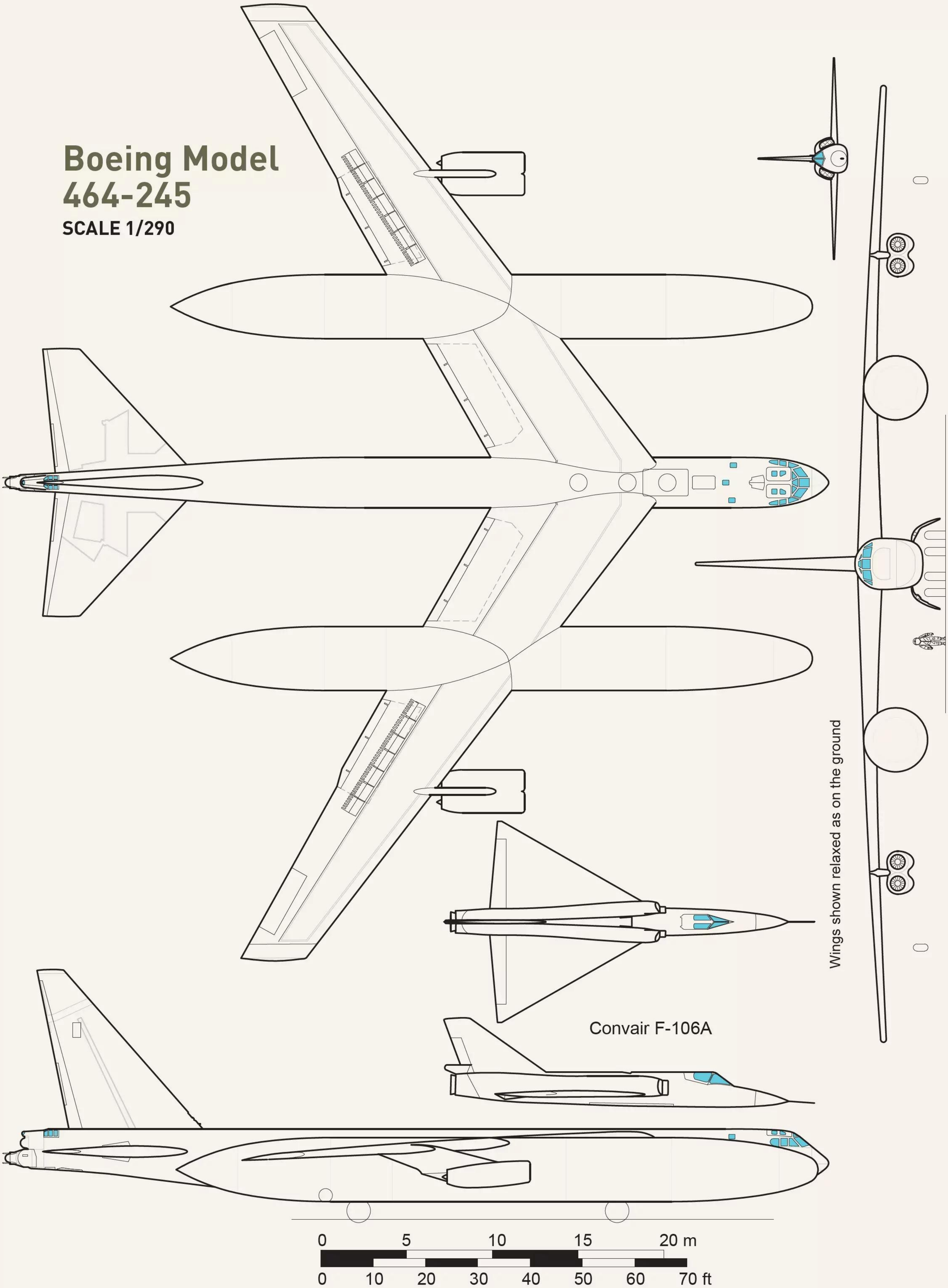


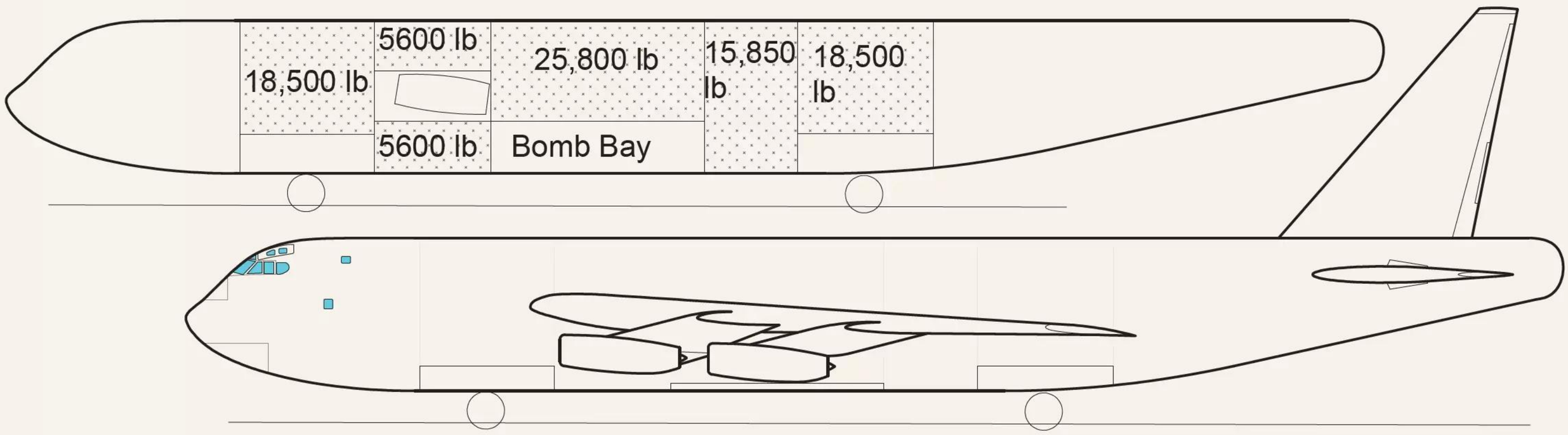
Boeing Model 464-246

SCALE 1/330

Wings shown relaxed as on the ground

0 5 10 15 20 m

0 10 20 30 40 50 60 70 ft



Boeing Model 491

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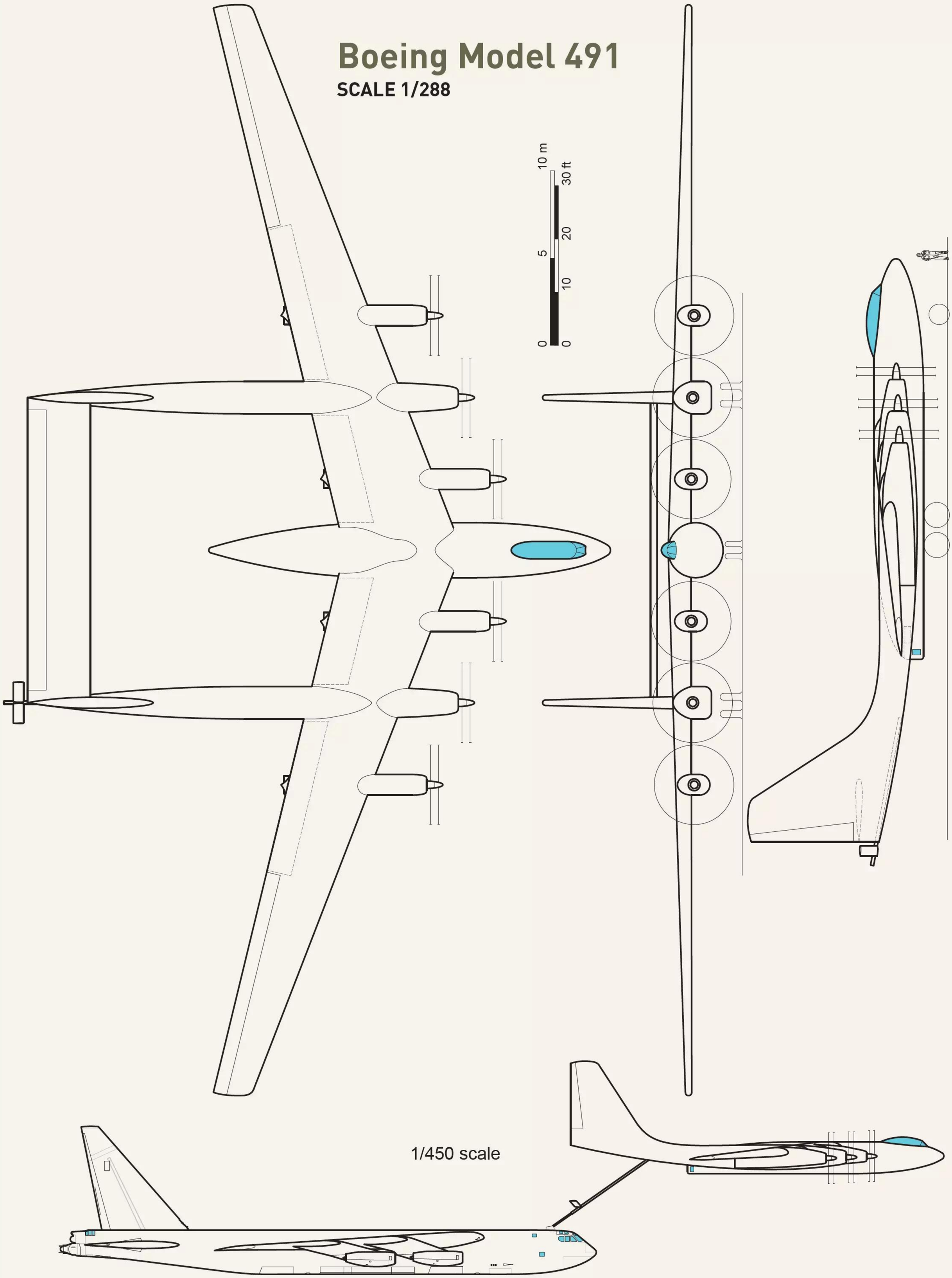

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4 CHAPTER

B-52 with Nuclear Power

As atomic power burst onto the scene in the mid-1940s, it brought with it the potential to power… well, everything. Nuclear powered ships, submarines, rockets, tanks, trains, airships, trucks and even cars were proposed at various levels of seriousness, with nuclear power proving itself practical for ships, submarines and space probes. One area that saw nearly as much effort, but nowhere near as much success, was the concept of nuclear power for the propulsion of aircraft.

There was apparently some interest in nuclear aircraft propulsion as far back as Second World War Germany, though they had no hope of making it work. It was not until the NEPA programme (Nuclear Energy for the Propulsion of Aircraft) was begun in 1946 by the United States Army Air Forces that a realistic and systematic effort was started to study the physics and engineering of nuclear aircraft. Until the last gasp of the programme in 1961, NEPA and its successor ANP (Aircraft Nuclear Propulsion) studied a wide range of reactor-based engines and a wider range of aircraft to be powered by them.

Most of the engines married a reactor with a turbojet, some a reactor with a turboprop, a few a reactor with a ramjet. In all cases the function of the reactor was the same: to provide a vast amount of heat. To recap: a conventional turbojet (or turboprop) works by compressing atmospheric air, forcing that into a combustion chamber, it with a chemical fuel, and blowing the resulting really hot air past a turbine that is spun by the exhaust. The spinning turbine is used to power the compressor. Turbojets obtain thrust directly from the high velocity exhaust gas while turboprops extract as much mechanical power as they can from the exhaust and use it to turn a large propeller (or a smaller propeller at very high rotation rates).

A nuclear turbojet works almost exactly the same, except that it replaces the chemical combustion with nuclear heating of the compressed air. This can be done directly or indirectly. In a direct system, the compressed air flows through the reactor itself. This system has the advantages of being relatively lightweight with a high efficiency of transfer of heat from the reactor to the air. But it also is a safety and environmental nightmare: little bits of the reactor, sometimes as small as individual atoms, are constantly spraying out of the exhaust.

Anything the engine might swallow, from dust to rain to snow to insects to birds to shrapnel, could get lodged in the reactor and caused localized superheating, or could knock chunks out of the reactor, or could get irradiated enough to become fallout. Direct nuclear turbojet designs are thus often not highly thought of except for weapons systems to be used on Doomsday, when leaving a trail of radioactive carnage in the vehicle's wake is not a bug, it's a feature.

Indirect nuclear turbojets separate the reactor from the jet. The reactor does not heat the air directly, but heats a fluid. In this case the fluid could be a gas such as helium, or it could be a relatively low melting temperature metal such as sodium, potassium or bismuth. The fluid is passed through the reactor and heated, then passed down the length of a high-temperature metal pipe from the reactor – usually safely ensconced within the fuselage – to the turbojet.

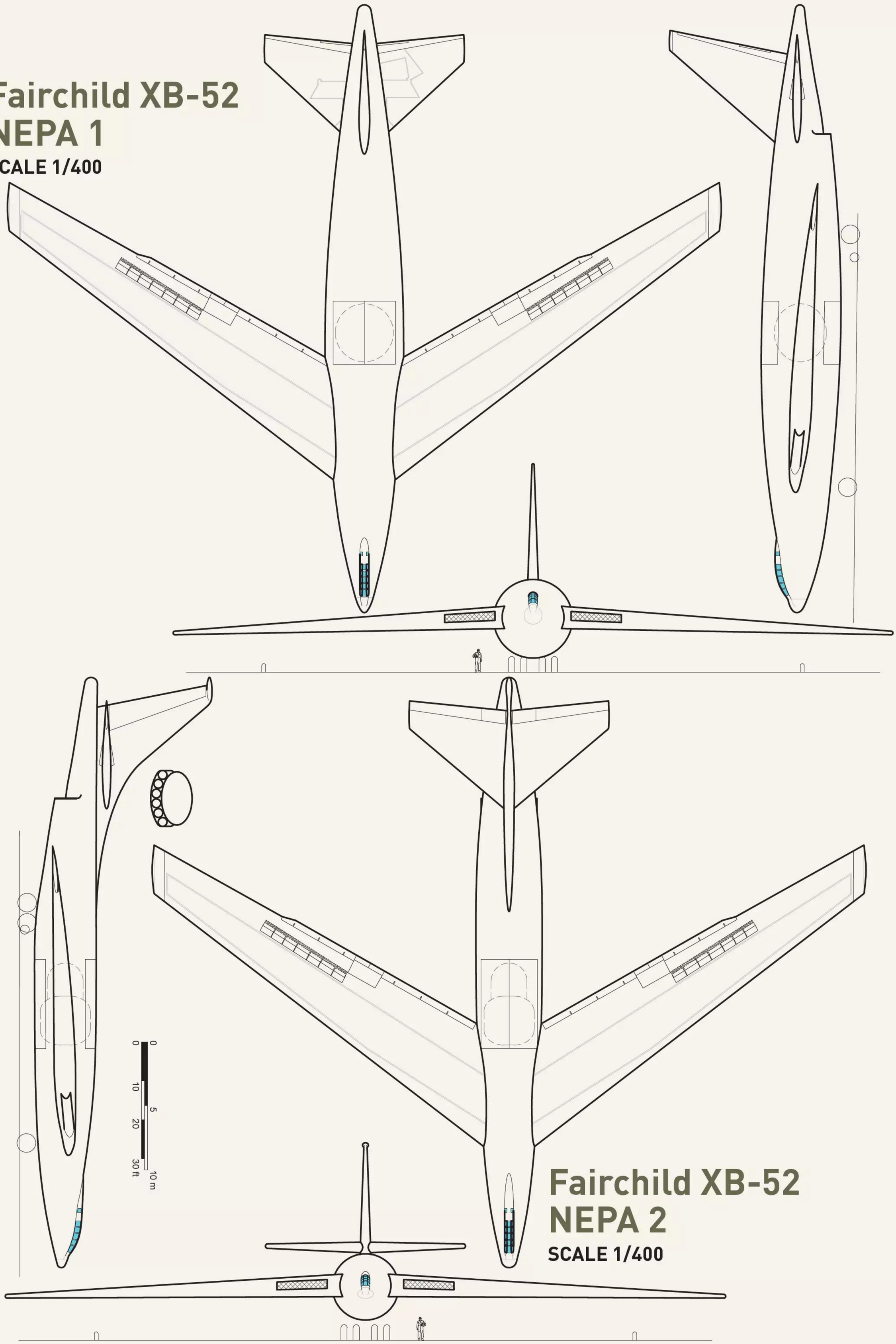
The fluid then passes into a heat exchanger in the combustor section of the jet engine; the extremely hot fluid gives its heat to the compressed air, replacing the combustion of air and jet fuel. The cooled fluid then flows back to the reactor to be heated again. This is a complex, heavy, less efficient system – but it has the important benefit of separating the reactor from the atmosphere. Anything that comes into direct contact with the reactor is separated from the atmosphere by impermeable metal walls.

NEPA began on May 26, 1946, when a contract was signed with the Fairchild Engine and Airplane Corporation. While other companies would enter the world of nuclear aircraft and engine design in the coming years (Lockheed, Boeing, Convair and Northrop gave considerable study to nuclear powered aircraft, while General Electric and Pratt & Whitney did a great deal of work on the subject of nuclear turbojets), Fairchild had the lead.

For several years however, the designs Fairchild produced seem to have been mostly vague and speculative, doubtless a result of the technology being itself vague and speculative. Still, Fairchild designed a wide array of military aircraft that would use nuclear power for flight. Most were entirely new configurations but several were based on existing aircraft. Unsurprisingly Convair's B-36, with its vast payload capability, was a common choice of aircraft to base nuclear powered designs on; this would halfway come to fruiting with the development and flight, starting in 1955, of the NB-36H. This aircraft housed a reactor capable of

Fairchild XB-52
NEPA 1

SCALE 1/400



Fairchild XB-52
NEPA 2

SCALE 1/400

producing one megawatt. It used air for the reactor coolant, but did not use the resulting heated air to actually power anything. Instead, the NB-36H was merely a testbed to see how materials, systems and maintenance techs would react to a flying reactor. A planned follow-on, the Convair X-6, would have incorporated actual nuclear-powered turbojets.

While the B-36 had the lift capacity to carry a reactor, it was slow and not at all representative of the sort of high-speed combat aircraft that the Air Force might someday operate with pure nuclear power. A demonstrator for such an aircraft was needed, and even though the B-52 had not flown and the design wasn't even necessarily firmly established, it was still used as the basis for a number of early concepts.

A Fairchild report of 1950 illustrated a pair of concepts for B-52 based nuclear powered aircraft. The first utilized the wings, tail surfaces, landing gear and, it seems, the cockpit of the XB-52 configuration, with an entirely new fuselage and a very different propulsion system. This vehicle would use a direct (air cycle) nuclear turbojet system with a single heavily shielded reactor.

Air from wing leading edge inlets would be ducted to the compressors of the six jet engines (modified XJ-57s) embedded in the rear fuselage. The compressed air would then be ducted through the reactor; the air would cool the reactor and in the process be raised to incandescently hot temperatures, then fed into the combustor sections of turbojets to drive the turbines. The resulting exhaust would be directed down to a series of nozzles wrapping around the underside of the rear fuselage. It was found that an XJ-57 modified for nuclear heating would be 15% heavier than a conventional version of the engine. The convoluted paths the air would take from inlet to compressors to reactor to turbines to exhaust nozzles would make the ducting complex, space-consuming and heavy.

While the wings were based on those of the B-52, the reality was that they would be substantially redesigned. The B-52 does not, after all, have sizable leading edge air inlets nor internal ducting. The engine nacelles spread along the wing of the B-52, along with the fuel in the wing tanks, provided a spanwise load that reduced the moment imposed at the wing root… but the wing of the nuclear version did not have those loads, increasing the torque and thus necessitating structural strengthening. As a result, the wing of the nuclear aircraft would be about 45% heavier than the stock B-52 wing.

Fairchild believed that the crew could be kept safe from reactor radioactivity by putting a massive shield on the forward side of the reactor, and a separate circular shield at the aft end of the crew compartment.

A similar configuration was presented that was to use a helium cooled reactor. The low density of compressed, super-heated helium meant that the pipes required would have to be large in diameter. Also, the low molecular weight of helium coupled with its high temperature would make leaks inevitable; some would simply seep through the metal itself. While sitting on the ground, helium in the system would remain a gas with the reactor powered down.

As mentioned earlier, an alternative to helium would be a liquid metal such as sodium. Helium had the advantage that a substantial leak, such as might be expected due to the aircraft getting hit with shrapnel or buffeting, would result in a jet of superheated inert helium. Unfortunate, to be sure. But compared to a leak of superheated and highly flammable liquid sodium metal generating a white-hot flame akin to a magnesium fire, the jet of hot helium would be comparatively benign.

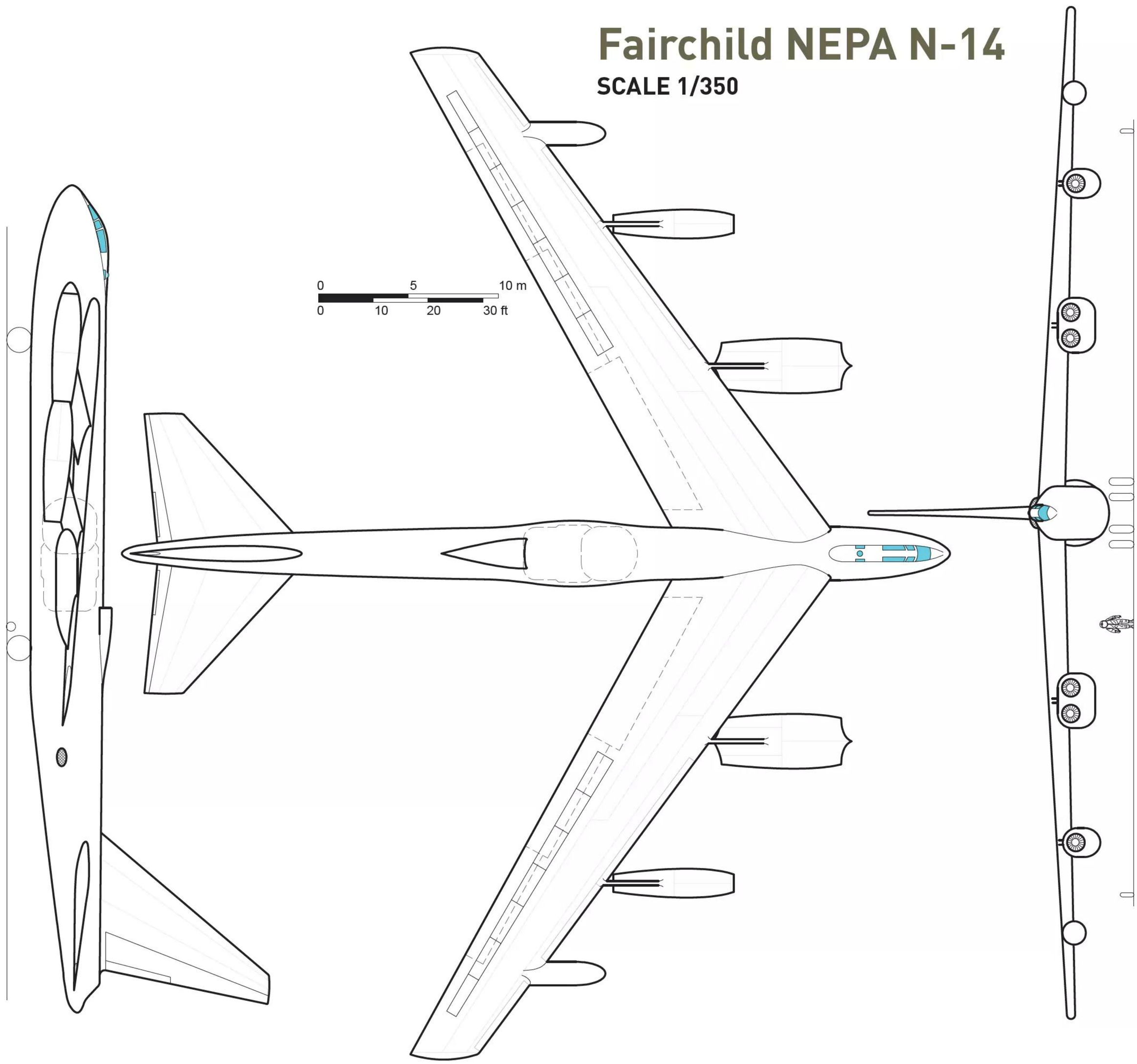
Additionally, sodium would not simply remain liquid with the reactor powered down on the ground – it would start to solidify. This would structurally stress the pipes and make re-melting the whole system difficult, so an operational nuclear aircraft would have to either offload the liquid metal or keep it molten during down times. The former process was the plan where liquid metal was specified, with the need to tap off hot, readily flammable (sodium and lithium will both spontaneously combust on contact with air at room temperature) liquid metal, filling the lines with an inert gas instead. This doubtless would have been the cause of many an incendiary incident.

These designs based on B-52 components were expected to be technology testbeds or at best interim tactical aircraft. To obtain the best performance and most optimized designs using nuclear propulsion, blank-sheet designs would be required.

Fairchild continued to study nuclear powered aircraft, including B-52 derivatives, for a several more years. In 1952 the company released a report discussing a range of aircraft designs, both clean-sheet and modifications of existing aircraft such as the B-36, the C-99 and the B-52. Here the designs used a liquid metal (sodium) coolant system, with the metal cycling through the reactor on a short loop, passing through a heat exchanger not within the turbojets but right next to the reactor. The thermal energy would be passed on to a second loop of liquid metal and that second much longer loop would pass through the turbojets.

The purpose of this was to aid in maintenance. As the metal passes through the reactor it becomes dangerously radioactive. So by keeping it to a short loop, the total mass of radioactive liquid metal would be minimized. The rest of the liquid metal in the system could be dealt with much more readily, the maintenance crews only needing to worry about being burned to ash by a small leak. There were of course inefficiencies in the system: the reactor had a maximum wall temperature of 1,400°F, but the turbine temperatures dropped to between 1,225° and 1,250°.

The reactors had multi-level shielding… an inner layer of borated water surrounded by a layer of borated gasoline to absorb neutrons; steel and lead plates on the forward side



provided gamma ray protection. The crew compartments were to be shielded with lead and plastic plates, though the details on that are lean.

Fairchild NEPA N-14

The N-14 was a relatively straightforward modification of the XB-52 configuration and appears to have existed two years earlier as the 'IL-1' configuration. The N-14 was a liquid metal cooled design using long insulated pipes to carry hot liquid sodium from the L-14 reactor to turbojets in pods much like those of the XB-52. The engines were different than those of the XB-52, however, being modifications of the planned General Electric J53 turbojet. There would only have been six of these, with inboard two-engine nacelles similar to (but longer than) the inboard nacelles on the actual B-52 and with each outer nacelle holding a single engine.

The nuclear reactor, with a maximum power output of 151,000 BTU per second, would be positioned in the fuselage just aft of the wings. The reactor and its shield were so large (outer diameter of 58in) that the fuselage needed to be bulged outwards to accommodate them; in addition the rear fuselage was extended a further 12ft. The secondary liquid metal lines required valves on either end to minimize leakage. The lines averaged 123ft in length and had a total planform area of 520sq ft.

Pumps kept the coolant circulating at 190lb per second per engine with a pressure of 75psi. This sped the liquid through the lines with a transient time of 4.9 seconds. The total powerplant weight was a hefty 179,400lb; much of

this was the reactor and especially the shielding (58,600lb for the reactor shielding, another 30,000lb for the crew compartment shield), but the pipes themselves would have been a major weight hit too… they would have had to be made of a material that remained strong and impermeable at the operating temperature of more than 1200°. This likely would have meant a high temperature alloy of steel and nickel, molybdenum, and/or tungsten.

All this led to aircraft performance that was somewhat lacklustre: top speed on pure nuclear power was a respectable 480 knots at 30,000ft, but rate of climb was, putting it charitably, pathetic. At sea level the aircraft clawed its way skyward at 1.5ft per *minute* on pure nuclear power, though rate of climb improved as the plane gained altitude. Thus the aircraft carried a supply of conventional jet fuel for some chemical thrust augmentation; rate of climb at sea level would go to a more respectable 5,800ft per minute. Time to climb from sea level to 10,000ft was 28.4 minutes; sea level to 20,000ft was 42.2 minutes; sea level to service ceiling was 85 minutes. With chemical augmentation these times would decrease to 1.8, 4.0 and 25.3 minutes.

While it might seem that the N-14 would be a straightforward modification of the XB-52, integrating the liquid metal pipes into the airframe would be no small task. The end result would be an aircraft capable of flight, but not capable of carrying out meaningful tactical missions; payload would only be 2,000lb. The relatively simple diagrams of the N-14 and N-15 (see below) design seem to show the outline of the as-built XB-52 canopy, but in reality the crew compartment would probably have been built quite differently to accommodate the required crew shielding.

Fairchild NEPA N-15

The N-15 was another design that was meant to be a relatively straightforward modification of the XB-52 configuration. The same basic reactor would be increased in power to 183,000 BTU/second, but that increased power would be fed to a reduced number of engines. The lone outer engine on each wing would remain but each inboard pair of modified XJ-53 engines would be swapped for a single engine. The four engines would receive a higher input of thermal power and would see higher turbine temperatures. This would lead to improved performance per engine, and substantially improved performance of the aircraft at low altitude.

On nuclear power alone, the rate of climb at sea level would be 1,100ft per minute, a vast improvement over the N-14. However, high altitude performance would not be as good as that of the N-14, with a lower top speed and substantially reduced service ceiling. Time to climb on pure nuclear power from sea level to 10,000ft was 9.2 minutes; sea level to 20,000ft was 20.2 minutes; sea level to the service ceiling was 45 minutes. With chemical augmentation, these times would be 3.2, 7.6 and 32 minutes. This is noticeably slower than the N-14, most likely due to the reduced number of engines.

Even with the increased reactor power output, shield weights would remain the same. The rear fuselage would not be stretched like the N-14's was. Payload for the N-15 was even worse than for the N-14 at a mere 400lb; clearly this was not the way to achieve an operational military vehicle. But for a test vehicle, it would have proved instructive.

Fairchild NEPA N-16

The N-16 was a modified B-52 in name only. The wings and tail surfaces would have been used but substantially modified; the fuselage would have been entirely new. The turbojets would have been relocated to within the fuselage in order to reduce the length, weight and losses of the liquid metal pipes. The B-52 landing gear was expected to remain largely unchanged.

Nuclear powered time to climb from sea level to 10,000ft was 16.2 minutes; sea level to 20,000ft was 26 minutes; sea level to the service ceiling was 54 minutes. With chemical augmentation, these times would be 1.5, 3.3 and 20 minutes. Nuclear climb performance was middling compared to the N-14 and N-15, but superior to both with chemical augmentation. But once again payload was essentially non-existent at only 300lb.

Boeing B-52A/General Electric LF-2

General Electric proposed a modified B-52 with a liquid metal cycle nuclear powerplant, the LF-2, in 1953. This used a single reactor that provided heated liquid sodium/potassium (NaK) to eight J73-GE-3 turbojets modified to have radiators in the combustors. The reactor was embedded within the core of a spherical shield 112in in diameter; this was in turn implanted within the B-52 fuselage just ahead of the rear landing gear.

The turbojets were clustered around the sides and rear of the fuselage, aft of the reactor. These would replace the engines under the wings, necessitating structural strengthening. However, this would still result in lower mass than the pipes, liquid metal and insulation required to feed the engines had they been in their normal positions.

The diagram included here is a provisional reconstruction based on diagrams of the engine installation included in a much later report. While the engine diagram is clear and detailed, it is unfortunately rife with inconsistencies (including showing the wrong diameter for the reactor shield and a substantial reduction in the depth of the B-52's rear fuselage). The configuration shown here is a best attempt at reconciling those issues.

Boeing Model 702-138(1) MX-2145

Boeing reported on the results of its studies for Air Force Wright Air Development Center project MX-2145, high

Fairchild NEPA N-15

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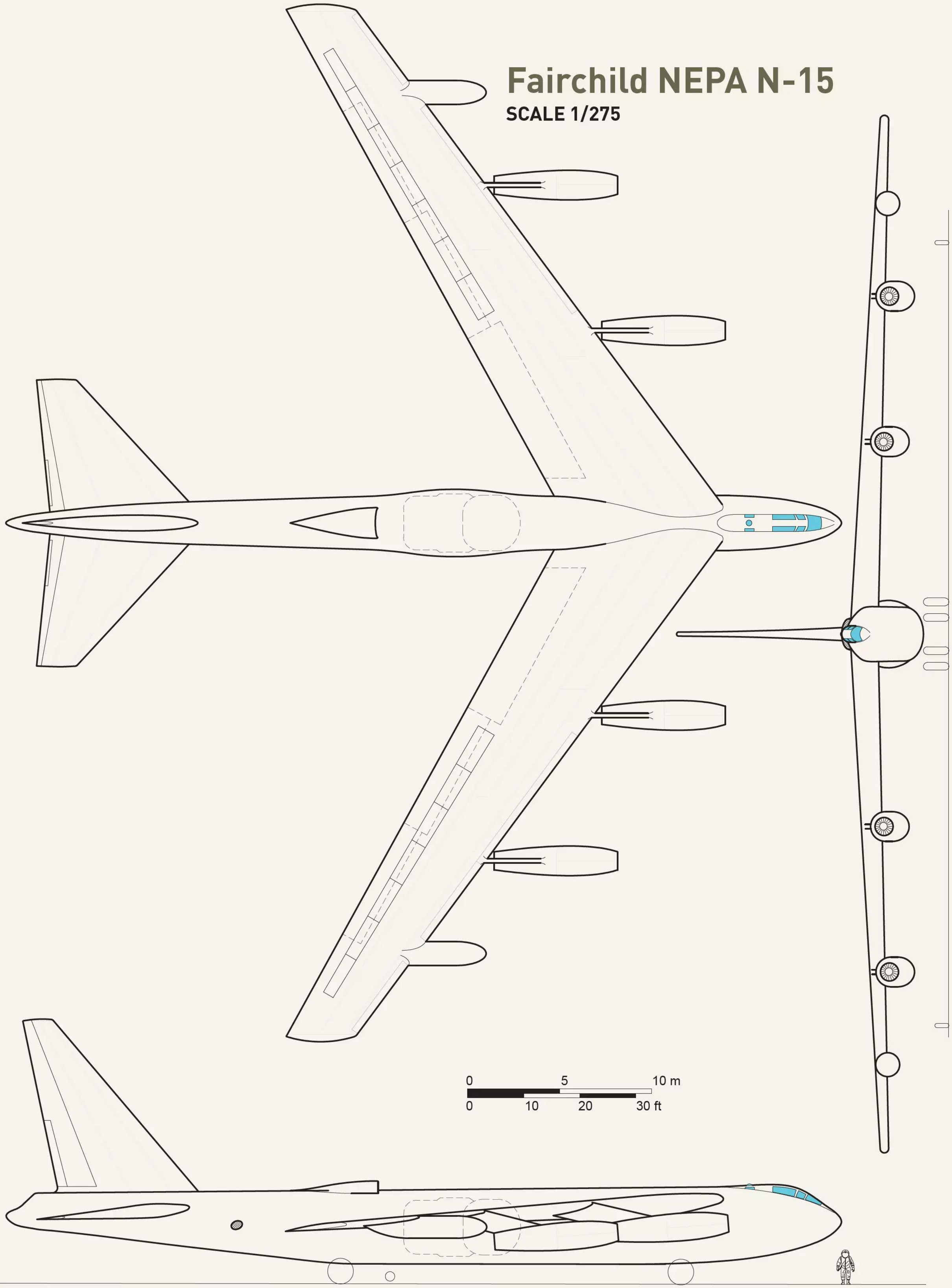

Fairchild NEPA N-16

SCALE 1/275

altitude heavy bombers, in January 1954. The basic aircraft was interpreted by Boeing to require an unrefuelled radius of 3,000 nautical miles, with a radius of 1,500 nautical miles from the target being flown at an altitude of at least 50,000ft. Payload would range from 10,000 to 40,000lb. For all aircraft, the bomb bay of the B-52 was chosen as the default since the size of the bombs that the Air Force might want to carry in the future was not available for the study.

Among the subsonic, supersonic, chemical and nuclear-powered designs was the Model 702-138(1). This was an all-nuclear design with a B-52-like configuration, including four pairs of engines in distinctly B-52-like nacelles. These were connected via high temperature pipes (filled with molten NaK) to a 124 megawatt reactor in the fuselage just behind the bomb bay. The crew were all contained in a heavily shielded cockpit compartment and were expected to be exposed to 0.1 rem per hour, for a mission lasting up to 23 hours. The technology of the aircraft, apart from the reactor, was expected to be available for a 1959 first flight.

Unlike many other available studies, here Boeing reported on some of the operational issues and characteristics of the nuclear aircraft. While grounded for maintenance or other reasons, the liquid metal reactor coolant would be drained and replaced with helium. This would allow the reactor to power down and be removed from the aircraft, being dropped down into pits for storage and maintenance in below-ground 'hotshops'.

It was estimated that the reactor could be powered down sufficiently to safely allow the flight crew to leave the aircraft within ten minutes of landing; the process of de-fuelling the aircraft – removing the liquid metal and nuclear fuel – would take ground crew up to three hours.

In order to fly again, either the chemical-burning engines or external auxiliary power systems would be used to get the liquid metal system up to temperature; the reactors would be loaded and activated at the last possible moment. However, it was found that it would take approximately three hours to prepare a bomber to fly, each bomber on a base requiring a dedicated 'filling station' during that time. A base with 12 such stations would only be able to prepare 12 aircraft every three hours – hardly the lightning fast response time needed to respond to a Soviet sneak attack.

Boeing designed hundred of nuclear powered bombers. The designs ran the gamut from surprisingly small to gigantic; subsonic to supersonic; conventionally configured to extremely weird. But something Boeing did not seem to do as much as one might expect is design nuclear powered versions of the as-built B-52.

B-52 Flying Testbed

General Electric spent years working on nuclear engine designs. By the time President John F Kennedy cancelled the programme in 1961, the company had two nuclear jet engines in advanced development: the XMA-1 used a single reactor integrated with two X211 turbojets, and the XNJ140E married a reactor to a single jet engine. Both systems were direct air cycle designs; both attached the compressors as close as possible to the front of the reactor and the turbines as close as possible to the back. Consequently these looked like turbojets with very fat combustors, rather than complex assemblies of pipes and engines and reactors.

While GE had tested the X211 turbojet components at operational conditions for the XMA-1 engine, it had then cancelled that engine in favour of the XNJ140E which seemed to hold more promise. Unfortunately, by the time of overall programme cancellation, that engine had not yet made it to hardware stage. GE had, however, drawn up details of how to test the engine. The Air Force had planned on using the Convair NX2 aircraft as a multi-engine demonstrator, an all-new aircraft configuration meant to demonstrate a practical tactical weapons system configuration. But GE felt that the B-52G could serve as a single-engine demonstrator.

The company studied several configurations, placing the XNJ140E-1 engine inside the rear fuselage or on top of it, but eventually it was concluded that hanging it in a special nacelle off the left side of the rear fuselage was the most practical option. The result seemed to mirror the Canadair CL-52, with a similarly outsized nacelle seemingly clumsily nailed to the rear of the aircraft, making it appear ill-balanced. As the engine assembly weighed 60,000lb, it certainly seems remarkable that the B-52G did not end up tail heavy – though the additional 30,000lb of shielding required for the cockpit would have provided some counter balance. Additional studies suggested that the B-52G could take a second XNJ140E-1 nacelle on the other side; two of these nuclear engines would allow the aircraft to shut down all four of its conventional J57 jet engines (the other four having been removed) and fly on purely nuclear power. Illustrations of this two-engine configuration are not currently available.

An interesting detail was pointed out: the crew's oxygen supply would need to be located in a low-radiation area of the aircraft… not because gamma rays of neutrons from the reactor would 'activate' the oxygen and make it radioactive, but because the radiation would spark the creation of ozone (O3) – chemically toxic to the crew. Other concerns were raised regarding some of the standard materials used in the B-52: elastomers in hoses, tyres, wires and seals, along with semiconductors and lubricants and hydraulic fluids would be negatively affected by radiation. These problems were not as well understood a decade earlier, but now they were known issues to be addressed.

The cockpit as shown looks unchanged but would have had to be completely new – a heavily shielded bunker like that of the Convair NB-36H.

Boeing B-52A/G.E. LF-2

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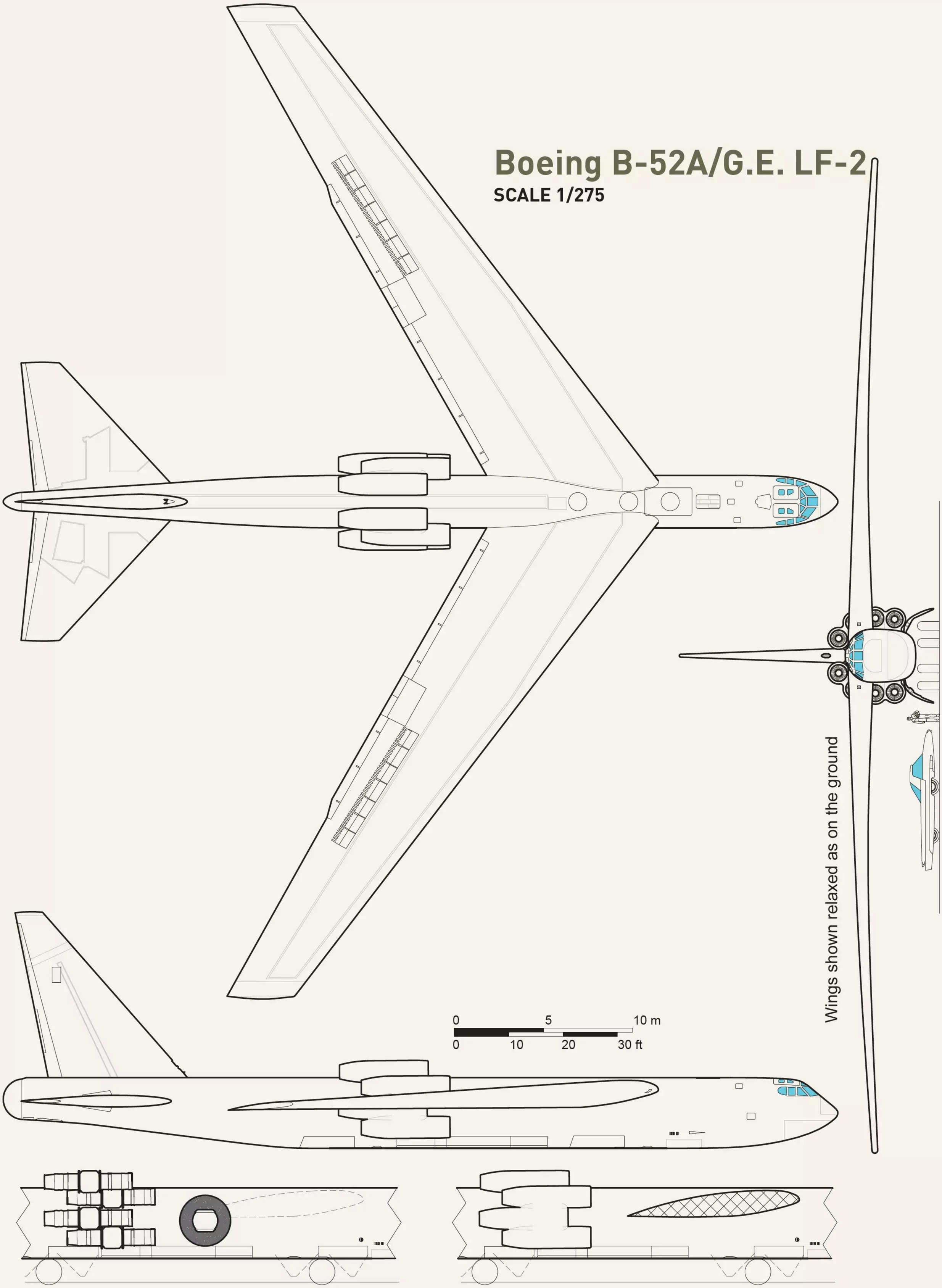

Boeing Model 702-138 (1)-1

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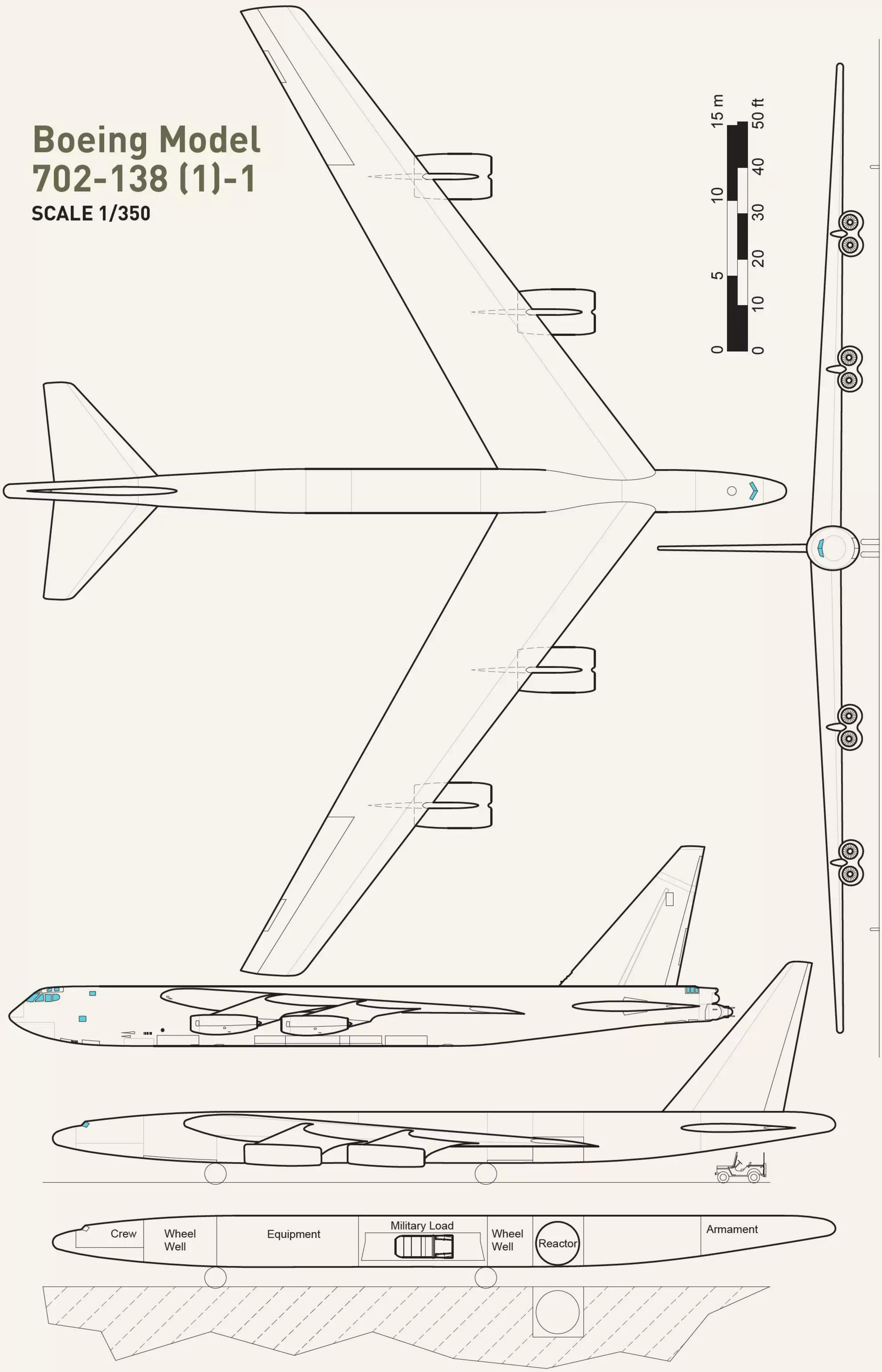

B-52 Flying Nuclear Testbed

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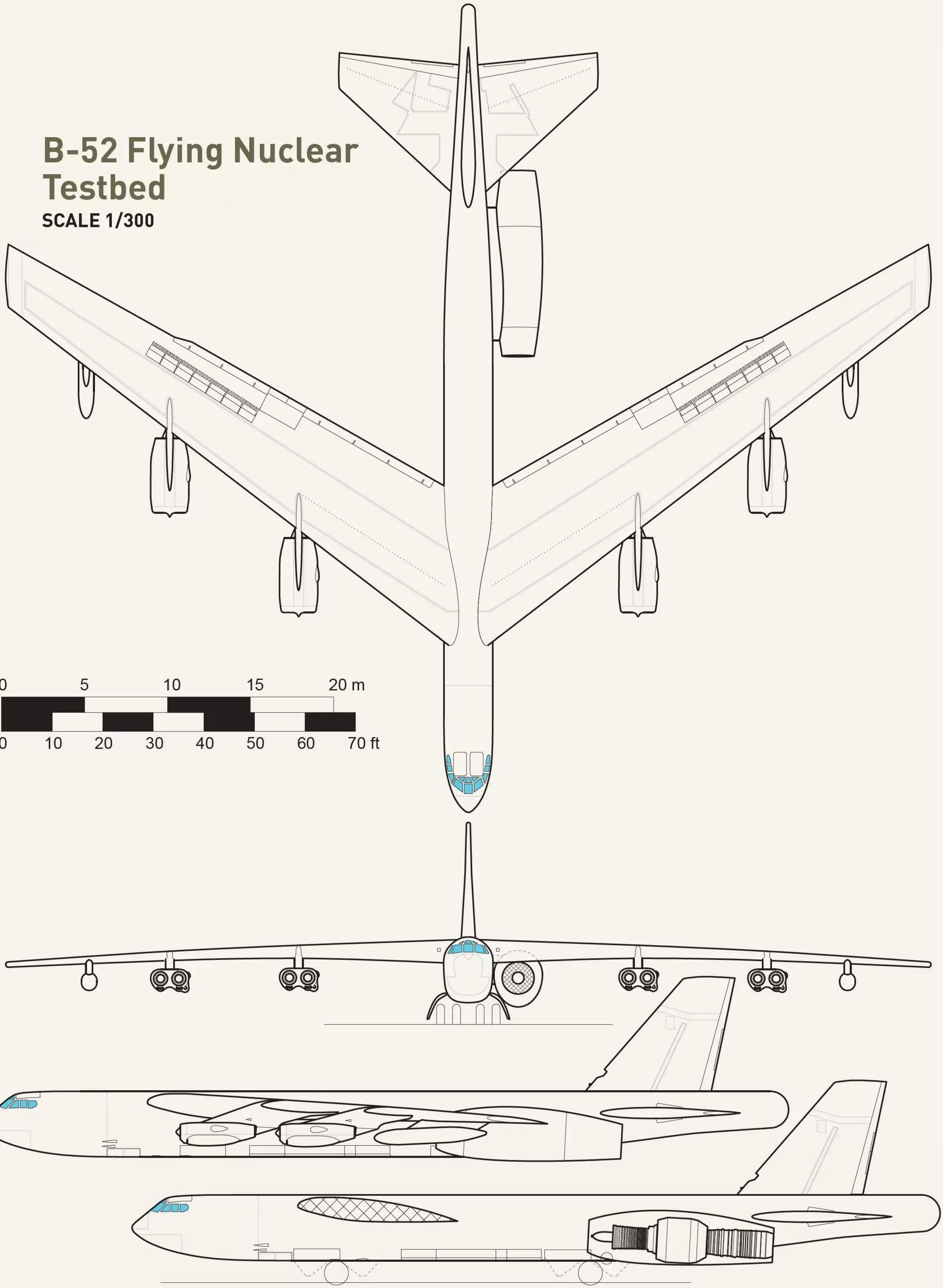

5 CHAPTER

B-52 Miscellaneous Designs

Boeing Model 703

A massively modified B-52 minelayer aimed at the Navy, Model 703 was designed in December 1951, at the same time as Model 450-150-30 (aka Model 704), a B-47 modified for the same role. It was about the same size as the Model 450-150-30, but featured aerodynamic refinements in line with B-52 design principles. The wings were not as swept as those of the B-52, but they shared the B-52's variable thickness ratios. The wings differed from those of the B-47 and B-52 in that they had substantial ailerons. The tail surfaces resembled those of the B-47.

Unlike that of the Model 450-150-30, the cockpit was fully faired into the fuselage like that of the B-52 and indeed bore a distinct resemblance to the B-52 cockpit. The four turbojets were in two pylon-suspended nacelles like those of the B-52, though fitted with Westinghouse J40-WE-8 turbojets rather than J57s. Unlike either the B-47 or the B-52, Model 703 was equipped with reasonably conventional tricycle landing gear. The main gear was composed of two dual-wheel bogeys that folded up into the fuselage and a conventional nose gear stowed under the cockpit.

The bomb bays, one in the forward fuselage and the other in the rear, separated by the wing and main landing gear, would be filled with up to 30 x Mk 36 1,000lb mines, or 15 x Mk 25 2,000lb mines, or 36 x Mk 50 500lb mines. For defence, Model 703 had a radar-aimed tail gun turret with two 20mm cannon. The gunner was in a unique location – beneath a low streamlined dome atop the middle of the fuselage. Performance data is not available.

Boeing Model 809-1004

This was one of the odder B-52 derivatives. Designed in early May 1957, this bomber was meant specifically for low-altitude operations. The B-52 had originally been designed for high altitude flight, to keep it out of the reach of enemy fighters, but as mentioned earlier advances in not just interceptor technology but also surface-to-air missiles made high-altitude subsonic bombing questionable at best.

Low-altitude bombers have different aerodynamic requirements than high-altitude designs; the thin air high up means lift is reduced, so wings need to be large. Low down, large wings are actually detrimental to an aircraft… making it susceptible to the turbulence and gusts that characterize the chaotic air closer to the ground. So Model 809-1004 was to be equipped with wings and tail surfaces that look shockingly small for a B-52.

But it wasn't the small wings that truly set the Model 809-1004 apart – it was the complete absence of podded engines below the wings. A casual glance might lead an observer to think that the aircraft had no engines. But in fact the aircraft not only had engines, it had a lot of them: 34 or 38 General Electric YJ-85-GE-1 turbojets were embedded within the wings.

The J85 was originally designed for the McDonnell ADM-20 'Quail' decoy. For this application it was made from lower performance materials; adequate to survive the single flight that the Quail would have. But it was soon improved with better materials and went on to successfully power aircraft such as the Northrop T-38 Talon trainer, the related F-5 fighter and the Cessna A-37 Dragonfly. All of these are quite small aircraft and the J85 itself is a small engine. The YJ-85-GE-1 planned for Model 89-1004 would produce a mere 2,450lb of thrust, and to do that it required a 20% water injection.

The small turbojets would be buried within the wings near the trailing edge. The wings would serve as long linear nacelles – the entire leading edge was a rectangular inlet and the entire trailing edge was an exhaust. A long narrow-chord flap lined the bottom edge of the exhaust; during normal flight this would block about half of the nozzle area; at slower speeds the flap would be deflected downwards and would open up the bottom half of the exhaust, which would be deflected directly downwards by the flap. The diagrams show that the wings could be fitted with 34 engines or extended slightly to fit in four more.

Model 809-1004 seems like the sort of thing that would be intended as a technology demonstrator, but it evidently it was aimed at becoming an operational bomber. The single 10,000lb payload (whether a bomb or a missile is not specified) it would be semi-submerged within one of

Boeing Model 703

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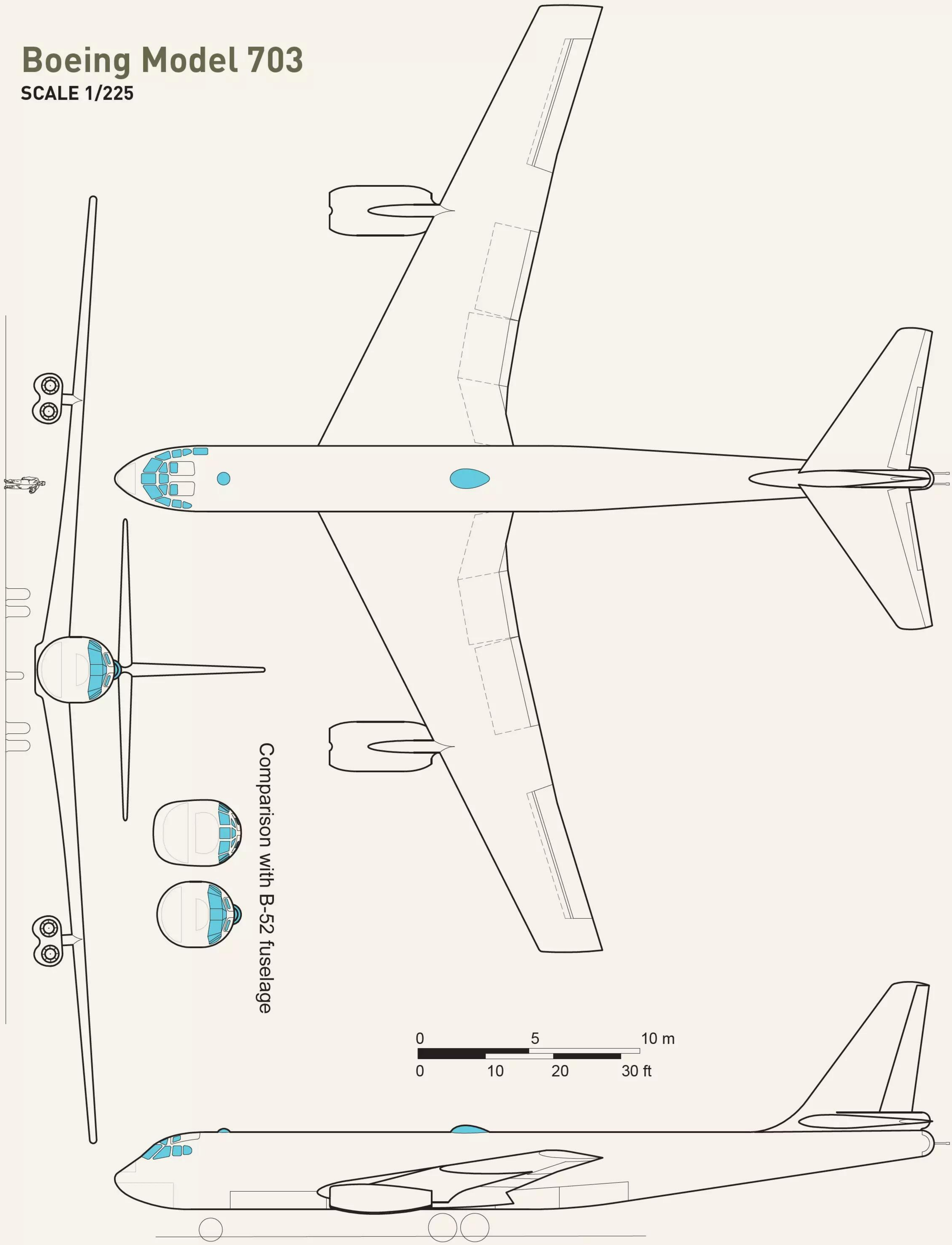

Boeing Model 703

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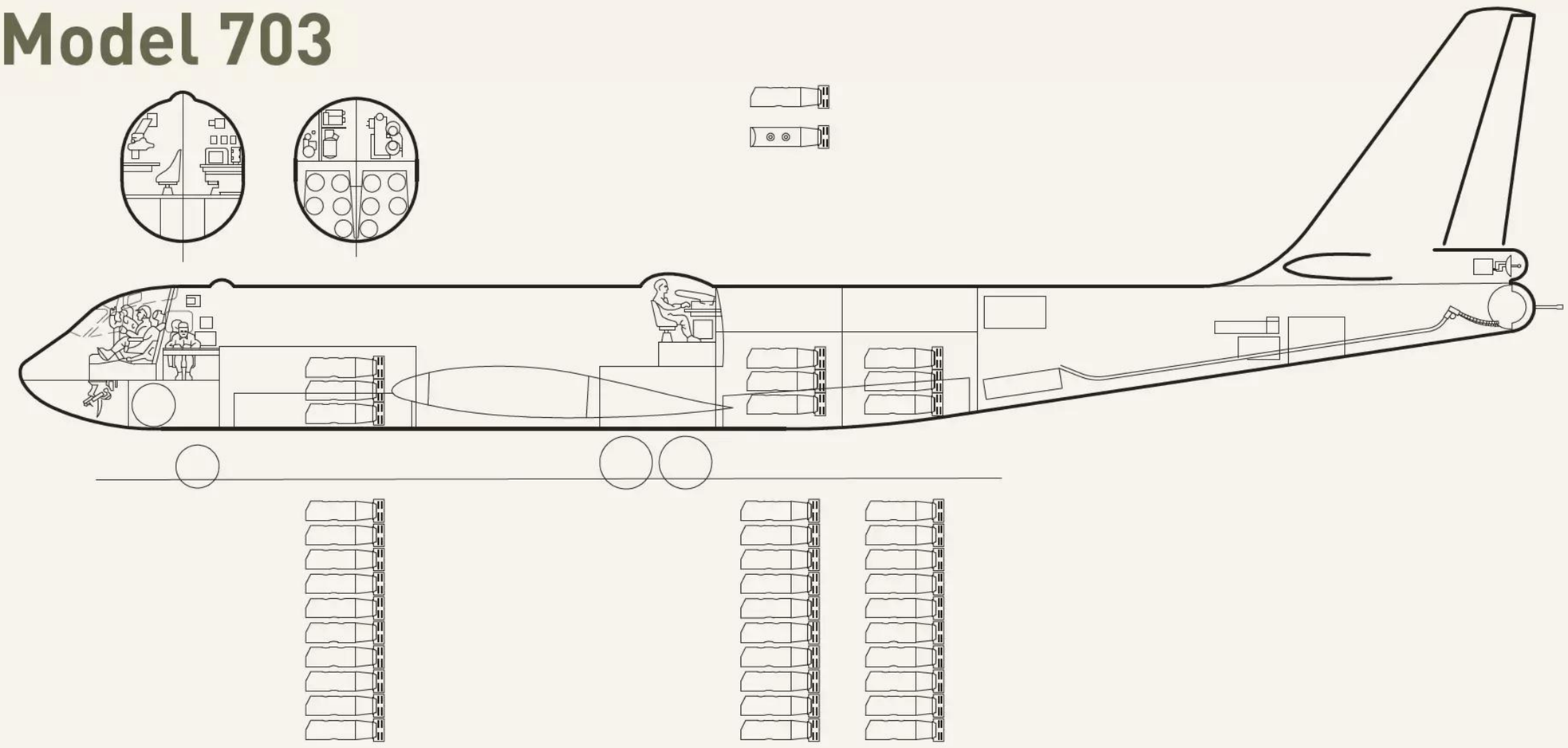

Boeing Model 809-1004-1

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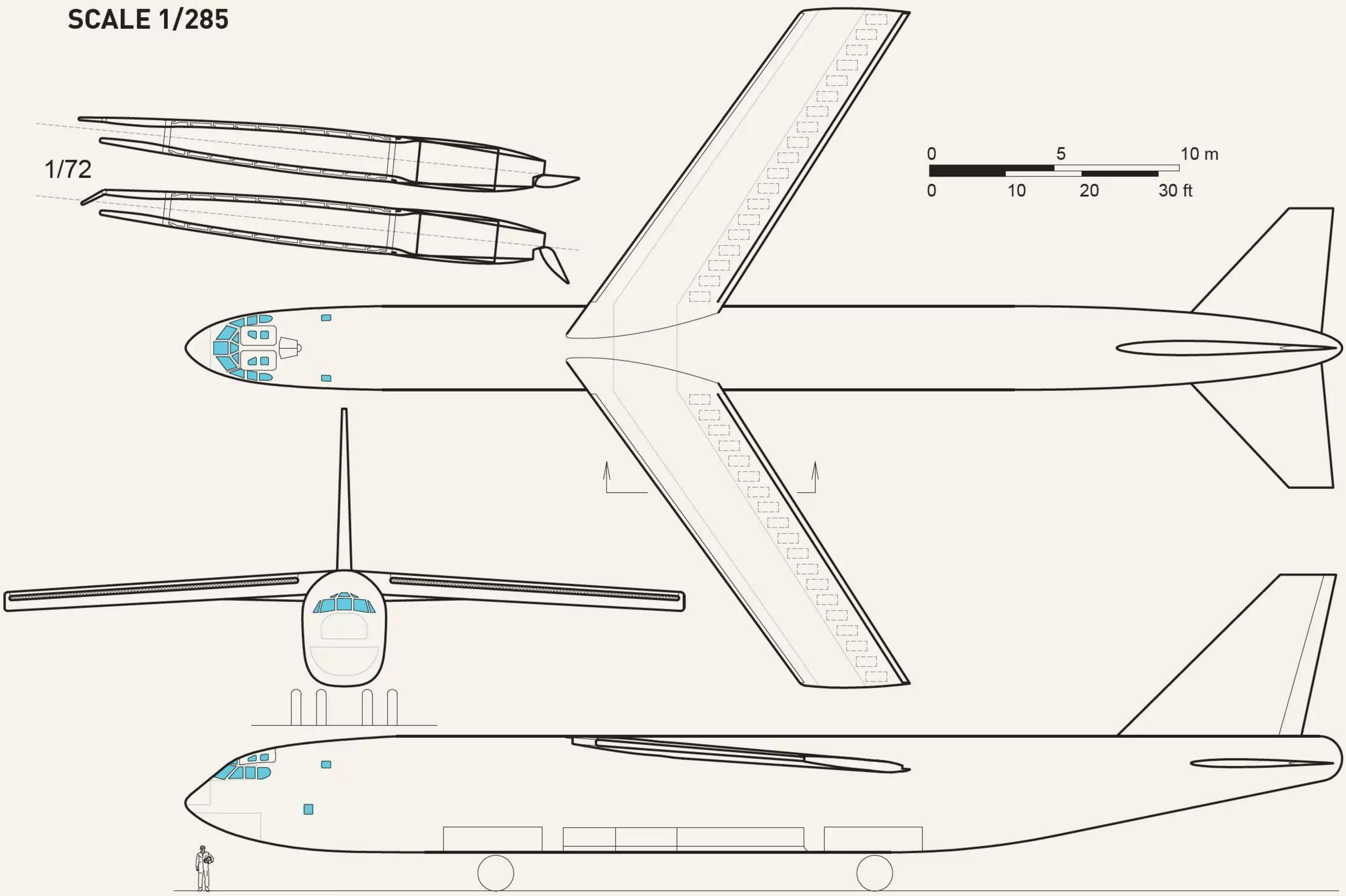

Boeing Standby Alert

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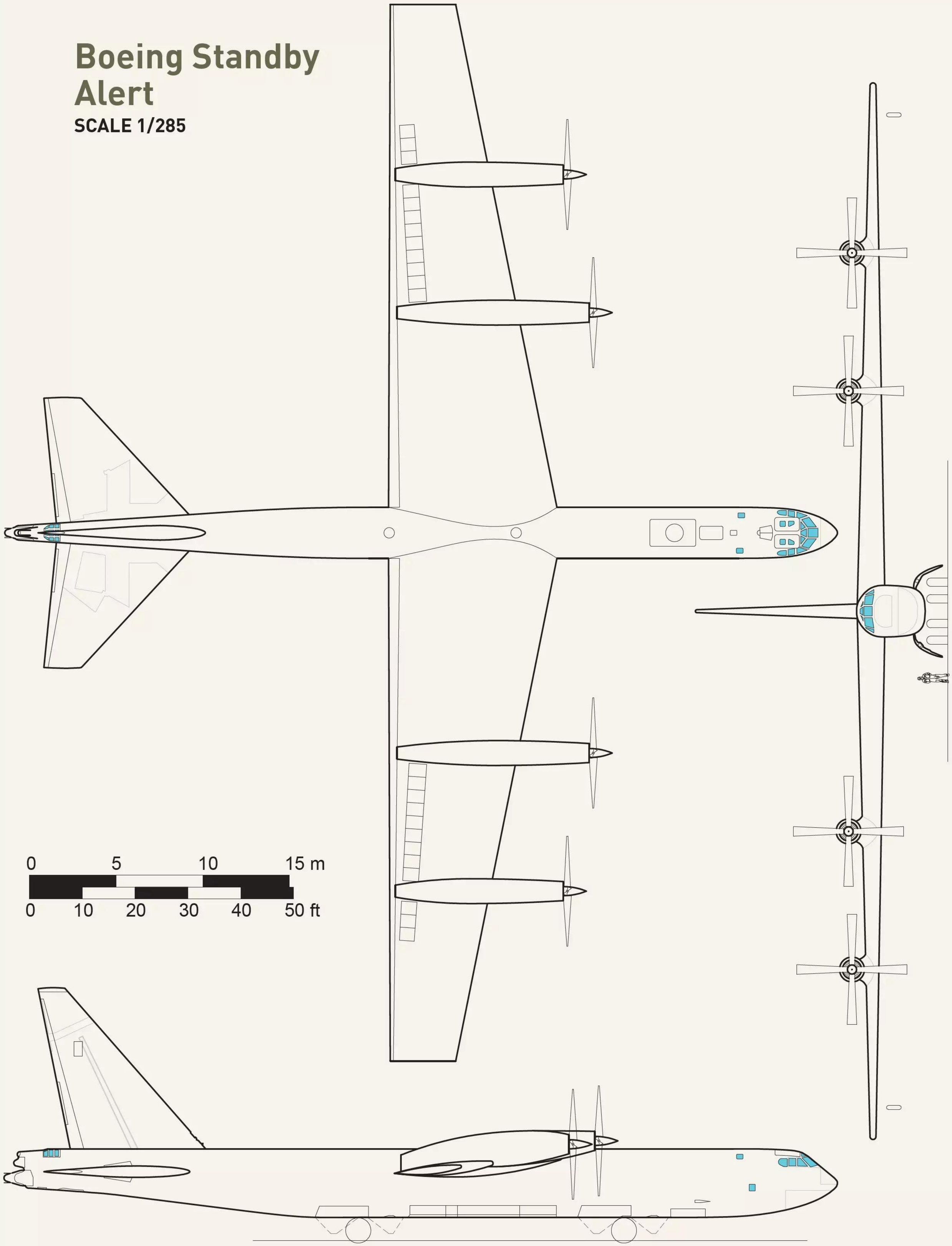

Boeing XB-52 + J75

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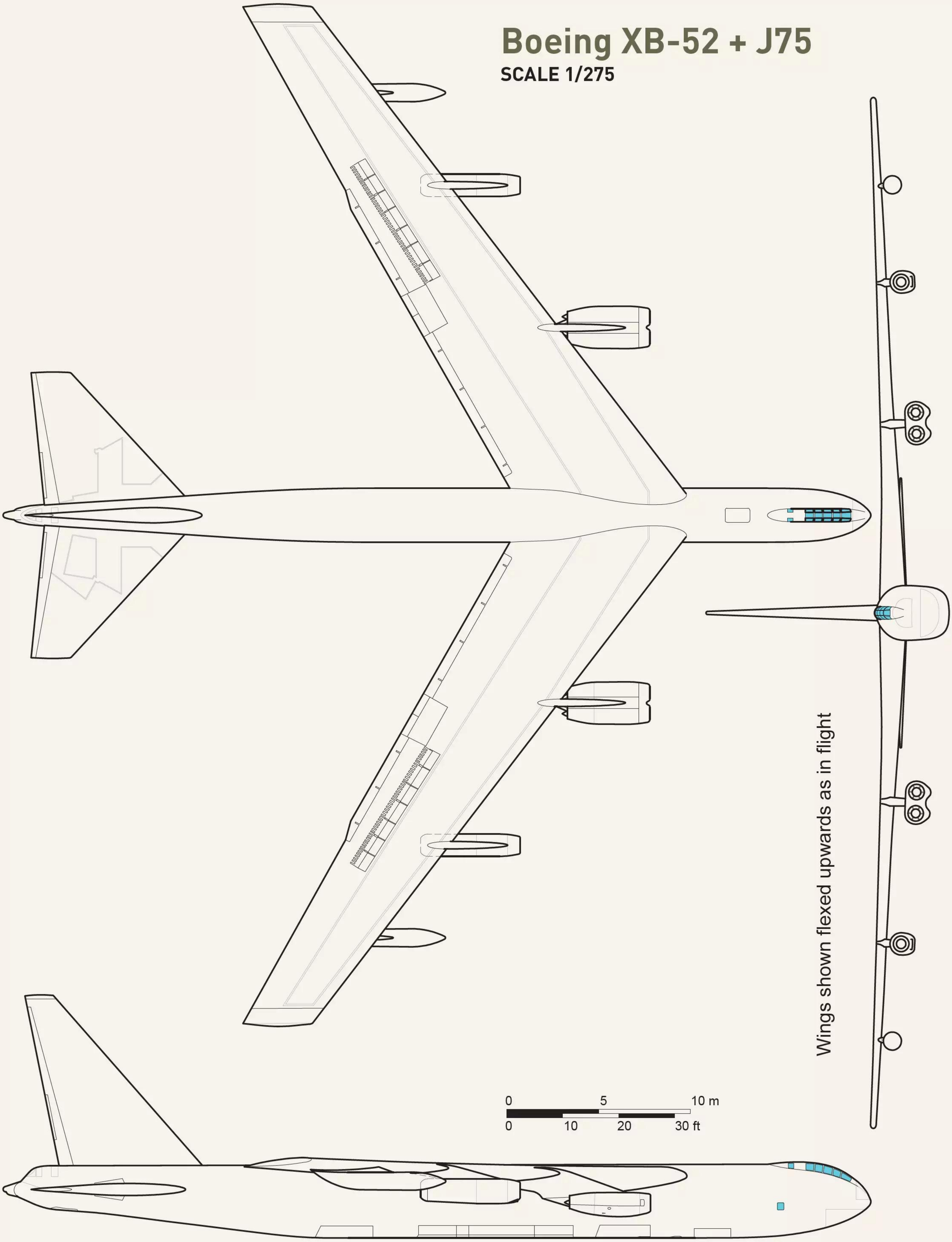

the fuel tanks, rather than carried in the bomb bay. If it was a nuclear gravity bomb, that bomb would definitely have to be of the 'laydown' variety in order to give the bomber a chance of escaping the blast.

At least two other Model 809 designs are known, a STOL bomber and a tail-sitting VTOL bomber. Model 809 was clearly used for some of the more unconventional thinking in bomber design.

Standby Alert

A somewhat crude preliminary concept for a 'Standby Alert Bomber' was shown in September 1959. This married the fuselage and tail surfaces of a standard B-52 to the Pratt & Whitney T57 turboprop engines and wings from a Model 820-101 transport design (see the chapter on transports) to create a new aircraft.

After the launch of Sputnik in October 1957, the US Air Force was keenly aware that the Soviet Union was rapidly developing the ability to strike American targets at a moment's notice. Having bombers sitting around inert, requiring hours to get into the air, was no longer acceptable. The Strategic Air Command resolved this problem with the 'Alert' system where bombers would be fuelled, armed and manned; essentially sitting at the end of runways, engines idling, ready to launch skywards within minutes of the command to do so.

It seems that the 'Standby Alert bomber' was intended to fulfil that very role, to either sit near a runway ready to go, or perhaps to be kept flying for extended periods, regularly refuelled. A turboprop bomber might not be as capable as a turbojet bomber, but a less capable bomber that survives a Soviet first strike because it is already in the air is infinitely better than the best jet bomber in the world after it has been evaporated by a Soviet ICBM.

Unfortunately the fragmentary information available to the author does not include performance data.

Engine Testbeds

Numerous attempts were made to replace the aging and inefficient engines of the B-52 over the decades, all of which have so far come to nothing since the introduction of the B-52H. Ironically, the B-52 has played host to more powerful and more efficient engines several times… but only as a flying testbed for the engine itself, not to demonstrate the potential of a re-engined B-52.

Boeing XB-52/J75

The virtually handmade XB-52 was substantially different from the operational B-52, so converting it into an operation bomber was not a practical possibility. Nevertheless it continued to provide some service even after its flight testing phase had ended. It arrived in Wichita for modifications in March 1957, the outboard J57 engine nacelles being removed and replaced with single afterburning Pratt & Whitney J75s.

The J75 in its military and afterburning form powered the Convair F-106 and Republic F-105; without the afterburner it propelled the Lockheed U-2. The civilian non-afterburning version, the JT4A, provided thrust for the Boeing 707 and Douglas DC-8 jetliners.

Some structural modifications were made to the wings to allow them to withstand the much higher thrust levels that the new engines would produce. The XB-52's YJ57-P-3 engines produced a maximum of around 8,700lb of thrust, but the J75 with afterburning could generate 24,000lb. A single J75 could thus produce around 1.4 times as much thrust as the two-engine J57 nacelle that it replaced.

The re-engined XB-52 was delivered to Wright-Patterson Air Force Base for testing in November 1957 but the result, as well as the extent of the testing, is unclear. Since the XB-52 survived to be unceremoniously cut apart for scrap in the mid-1960s, clearly the engines did not rip themselves off the wings.

Boeing JB-52E

Several B-52Es became notable in the late 1960s as they each had the inboard engines under their right-hand wings replaced with large turbofan engines. This was done to test out the new generation of turbofans intended to power the 'jumbo jets': Boeing's own 747, the McDonnell-Douglas DC-10 and the Lockheed C-5 Galaxy. These test flights provided valuable information but did not lead to serious efforts to re-engine the B-52s themselves.

All of the engines were high-bypass turbofans of much greater diameter than the TF33-P-3 turbofans used on the H-model of B-52, never mind the J57 turbojets used on the E-model. The large diameters of these new engines made fitting them under the wings of the B-52 a bit tricky; the end result being ground clearance comfortably measurable in inches. B-52E number 56-636 was given a Pratt & Whitney JT90-7R4, intended for the 747. B-52E number 57-0119 got a GE TF39 military turbofan meant for the C-5 programme; that type of engine evolved into the civilian GE CF6 which ended up on the McDonnell Douglas DC-10 jetliner. The aircraft was retired in 1981.

Flashback

One truly effective way to be intriguing is to be mysterious. And the 'Flashback' modification of a B-52C in the mid-1960s fits the bill perfectly. In this case, the modifications made to the B-52 are not the interesting part, but the 'Flashback Test Vehicle' (FBTV). This was a payload built and carried by a B-52, a payload intended to be dropped like a bomb. But was it a bomb? Was it a pure science experiment, or was it meant to lead to a practical

Boeing JB-52E

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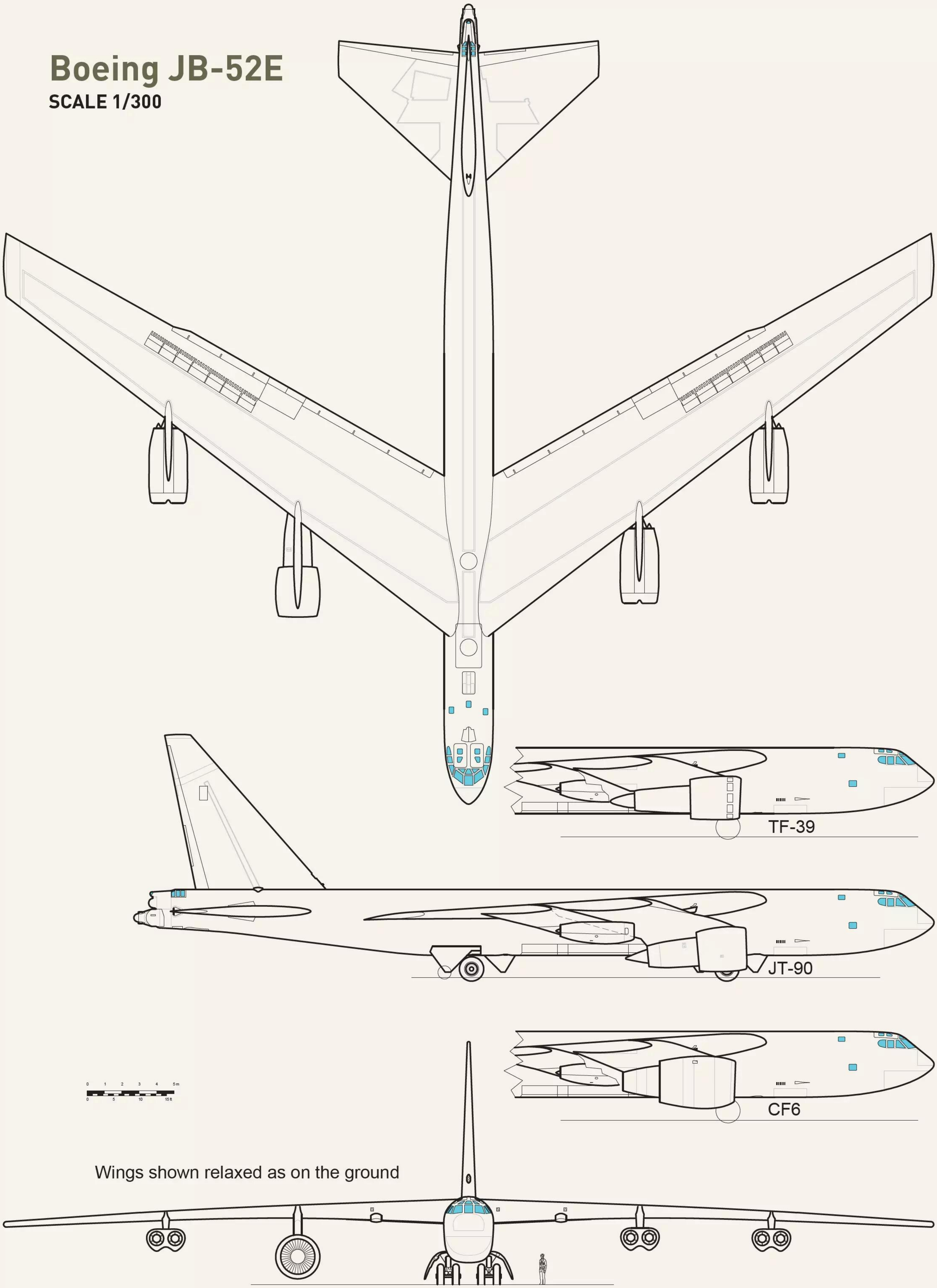

device? These and other questions remain unanswered, at least as far as this author is aware.

What is known is that in January 1965, the Flashback Test Vehicle was tested at Kirtland Air Force Base in New Mexico. These tests did not involve the dropping of a nuclear bomb which then detonated; such atmospheric tests were banned under the Partial Test Ban Treaty of 1963. Instead, the susceptibility of the Flashback device to electromagnetic emissions from the ARC-58 transmitter in the B-52 carrier aircraft and the device's own telemetry transmitters was the point of the test.

The Flashback device itself was large: large enough that in order to fit into the B-52 the bomb bay doors had to be removed – even then the device protruded from the belly of the aircraft. It was about 8ft in diameter and 24ft 9in long, not counting the protruding parachute pack or antennae.

The configuration of the Flashback Test Vehicle was distinctly bomb-like. At the front was a round-nosed cone that in configuration and dimension closely – though not precisely – match those of the Mark 6 re-entry vehicle from the Titan II ICBM. A short cylindrical section followed, with a tapering tail section with three wedge-like tail fins. In the rear of the tail was a large parachute package. The tail fins, it should be noted, are quite similar to the fins on large hydrogen bombs of the time. A number of antennae protruded from the rear of the device, presumably transmitters of onboard telemetry generated during a drop.

The Flashback Test Vehicle and modified B-52D (photos are at best blurry, but the serial number seems to be 56-620) were shown in some poor-quality photos and some decent-quality wind tunnel model diagrams. These diagrams were used to create the diagrams here and provide a good guide to shape and dimensions. The wind tunnel testing was conducted at the Cornell Aeronautical Laboratory in 1966; the testing was conducted for the Sandia Corporation, the designers of the Flashback Test Vehicle. Sandia Corporation operates Sandia National Laboratories, which is a premier nuclear weapons ordnance engineering laboratory… i.e. they designed nuclear bombs. The wind tunnel models of the FBTV and the B-52 were built from aluminium and supplied to Cornell by Sandia. The tests involved determining the aerodynamics not only of the FBTV within the B-52's bomb bay but also during a drop. It seems that the FBTV was planned for an actual drop from the B-52 in September 1967 over Johnston Atoll as part of Operation Paddlewheel; whether that drop occurred is unknown.

Intriguingly, during the test "all HE (high explosive) and nuclear components were deleted," and "a simulator was used to replace the warhead". So… what we have is a very large device that was intended to be dropped from a B-52, and which was supposed to have a nuclear warhead. It seems unlikely to be a stand-in for an existing bomb; any bomb then in existence could have been easier to use than something entirely new.

The Flashback Test Vehicle was larger by far than any other nuclear bomb in the US inventory at the time. It is a little bit bigger than the Soviet Tsar Bomba – the 50 megaton monster detonated in 1960 and designed to be 100 megatons in yield. Was Flashback a response to the Tsar? If so, it certainly seems like it could have been designed for a yield in the hundred-megaton range. But, after all that, why use the Mark 6 RV from the Titan? The Mark 6 RV contained a W-53 warhead with a yield of nine megatons.

There was no need to use Titan components in order to match the W-53 to the B-52; the B-52 was perfectly capable of carrying the B53 bomb, which used the W-53 and also generated a nine megaton blast. Dropped from a B-52, it was certainly not going to encounter re-entry conditions. The inclusion of a parachute pack shows that it was not going to be allowed to break the sound barrier on the way down; most likely it would begin deployment of the chutes almost immediately after being dropped.

Sandia was the original promoter of the 'laydown' bomb, one which used a parachute to lower the bomb relatively gently to the ground; upon landing the bomb would not necessarily immediately detonate but would instead wait a set period of time. This, coupled with the retarded descent, would give the bomber aircraft the time needed to escape; for a bomb with a yield potentially measuring in the hundreds of megatons, the B-52 would need every second it could get to get away.

Hopefully the Flashback story will come out one of these days.

Boeing NB-52E Control Configured Vehicle

The advancement of computers in the 1960s and 1970s allowed new ideas to be incorporated and tested. One such was 'Control Configured Vehicle' (CCV) technologies. CCV marries sensors with fast-acting computer control of aerosurfaces. When it works, this permits manoeuvring and ride control that human pilots are unable to provide. Ride control is especially important for aircraft that fly low to the ground, where air is disturbed by downdrafts, thermals and air flowing around and over terrain. An active control systems computer is able to detect the beginnings of a 'bump' and command aerosurfaces to create counter-forces, smoothing out the ride without pilot involvement.

The earliest computers that might have been able to handle these duties were too big, heavy, expensive and power-hungry. But by the 1970s, computers had reach the

Flashback Test Vehicle/B-52D

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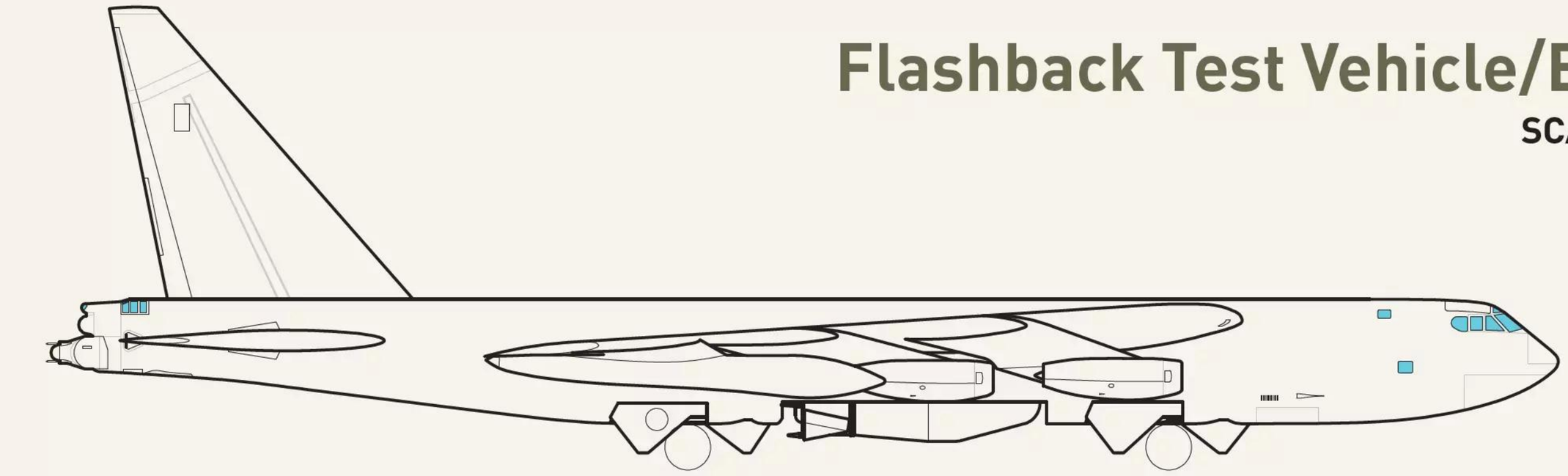

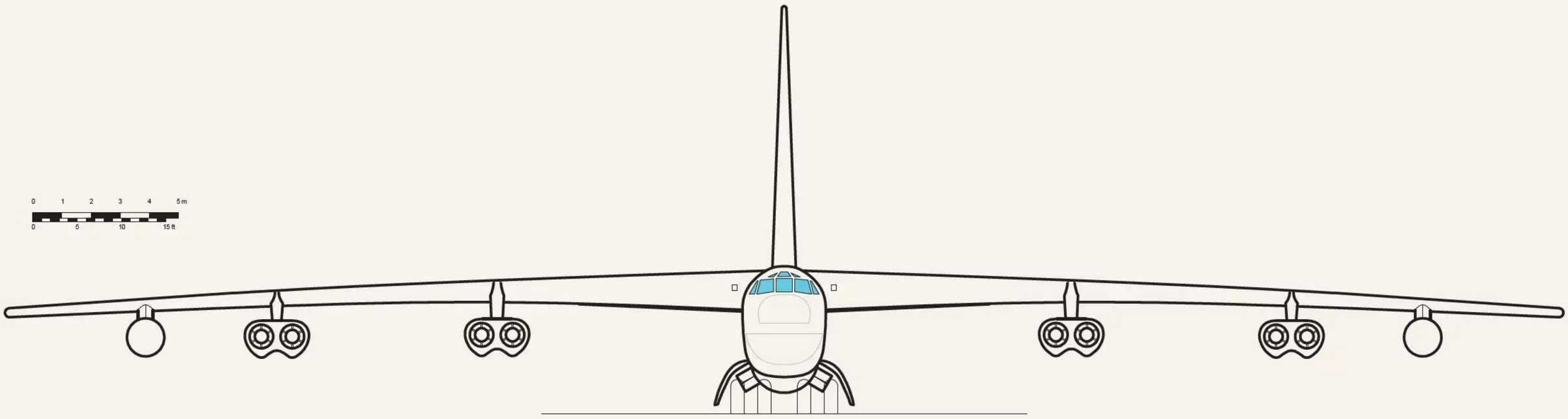

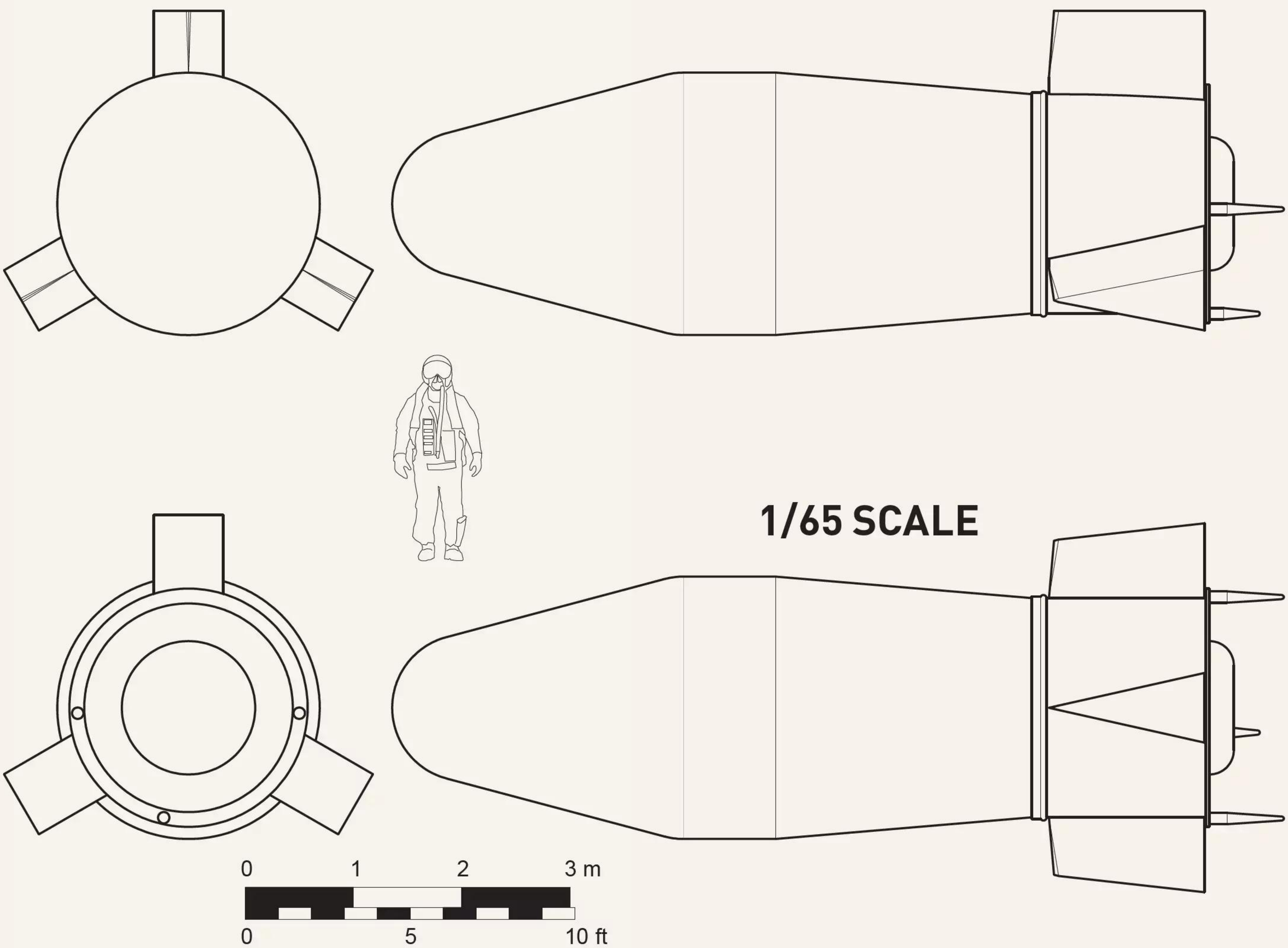

Boeing NB-52E

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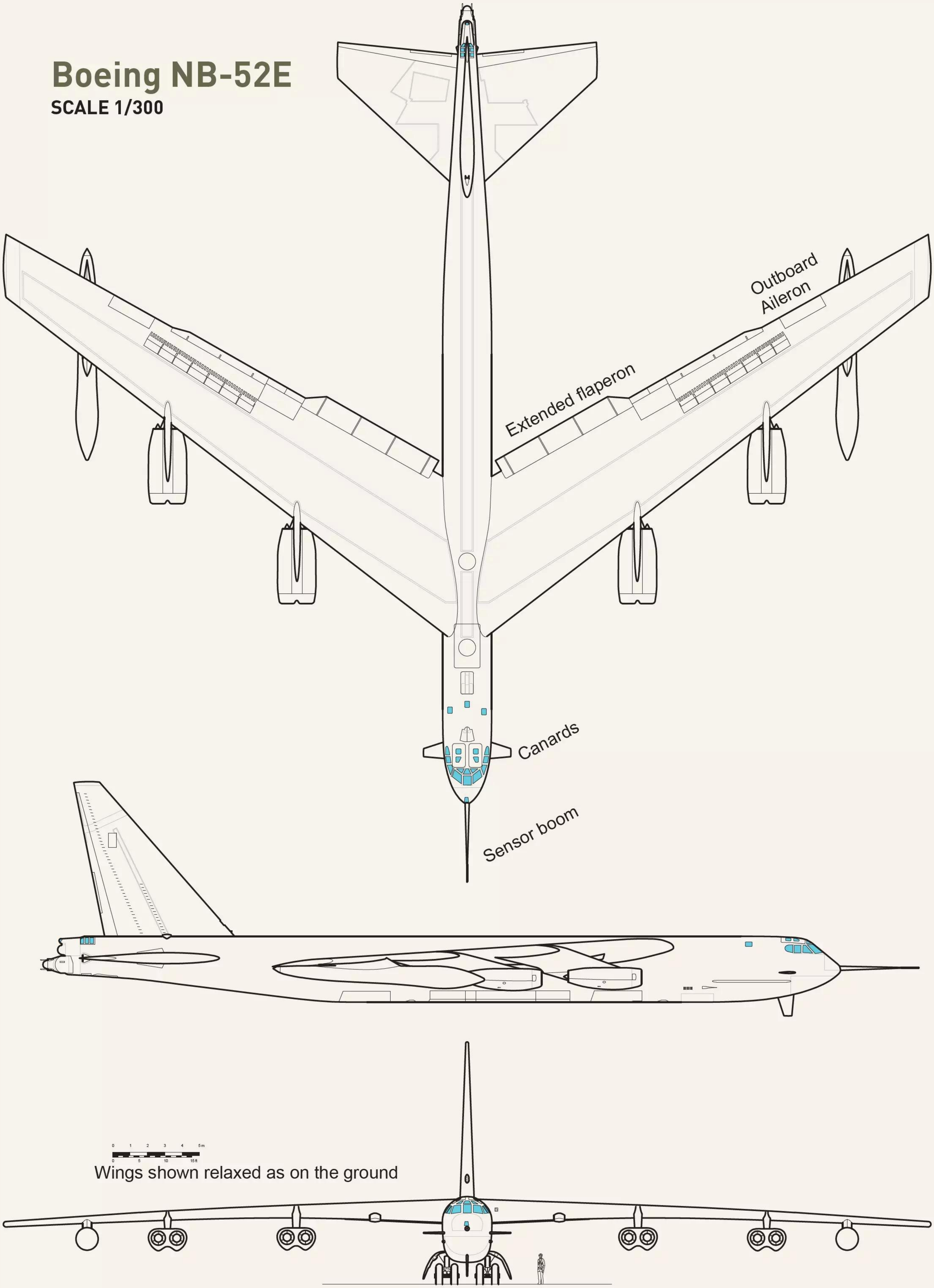

stage where aircraft designers could seriously consider adding active controls to military aircraft. But like any new technology, it needed to be tested. And so Boeing B-52E number 56-632 was selected for modification by the Air Force Flight Dynamics Laboratory and Boeing to test CCV technologies.

This aircraft had been previously modified in 1969 for the Load Alleviation and Mode Stabilization (LAMS) programme, a similar project to demonstrate gust load alleviation. LAMS included adding a sensor boom to the nose of AF56-632; hydraulic controls were added to the control surfaces and a fly-by-wire system was incorporated. The LAMS flight tests showed that using automated systems to tinker with the existing control surfaces in real time could indeed reduce loads on the aircraft imparted by gusts.

And so the CVV programme began in 1971, Boeing again working with the Flight Dynamics Laboratory. AF56-632 was given two horizontal nose canards for pitch control plus a vertical canard for yaw control below the nose. Ailerons, never previously a feature of B-52 wings, were added outboard of the outboard engine pylons; three-segment longer-chord flaperons replaced the inboard flaps. Each external fuel tank had 2,000lb of ballast added to its nose and two Electronic Associates Inc. Model TR-48 analogue computers were installed in the lower section of the fuselage nose. The flight control system remained fly-by-wire and the long nose boom previous added to the aircraft was retained. The changes were sufficiently drastic that the Air Force rebranded this aircraft as the lone NB-52E. It was painted in a distinctive red colour scheme with patterns on its wing and fuselage to aid in measuring responses when caught on film.

Flight testing CVV began in January 1973 and ended in November, helping to develop several systems in the process, such as Ride Control, Flutter Model Control, Manoeuvre Load Control and Augmented Stability. The systems demonstrated a 30% reduction in accelerations from turbulence, a 10 knot increase in flight speed above what would normally wreck it due to flutter, reduced wing root bending moments during manoeuvres, satisfactory flight characteristics when flown at neutral static stability and reduced fatigue.

After the successful test series, the aircraft was retired to Davis-Monthan Air Force Base in 1974 where it sat in the Arizona desert until it was scrapped in 1993.

Until the B-52J, the B-52H was the most recent major redesign of the B-52H. Recent, of course, is a somewhat relative term; the design of the B-52H began in 1959, more than 65 years prior to the writing of this book. The 'H' variant was characterized by the inclusion of the Pratt & Whitney TF33-P-3, the first use of a turbofan engine on the B-52, and it has flown with this same model of engine for six decades.

This is not because engines have not improved since the early 1960s; indeed, the 1.4:1 bypass ratio of the TF33 is now shockingly low for modern subsonic turbofan engines. The Pratt & Whitney PW2000 that powers the C-17 Globemaster III, for example, has a bypass ratio of 6:1; the Pratt & Whitney PW1000G that powers the Airbus A220 has a bypass ratio of 12.5:1.

Many engines developed since the TF33 have provided improved fuel economy, increased thrust, or both. A new higher-thrust, reduced fuel consumption engine would not only make the B-52 more economical to operate by reducing the fuel used, it would allow the B-52 to fly further and stay aloft longer. It is therefore not surprising that both Boeing and the US Air Force have expressed interest over the years in re-engining the B-52. And yet so far that hasn't happened.

There are a number of reasons why – treaty compliance and ground clearance being two of the more important, not to mention the ever-present excuse of up-front cost. Replacing the old engines with new ones, especially engines of greatly different size and thrust, would not be a simple process. The existing nacelles and pylons would have to be dispensed with and all-new pylons would be needed, especially if the eight TF33s were replaced with four higher bypass, larger-diameter turbofans.

The wing structure itself would also doubtless require structurally reworking in order to withstand thrust of a higher level and from a somewhat different vector. Electrical, pneumatic and hydraulic controls would need to be re-routed, replaced or augmented. The flight controls for the aircraft could well require substantial modification too. If a standard B-52H were to lose thrust in a far outboard engine, compensation would be relatively straightforward. But if a four-engined version were to lose thrust in an outboard engine, countering the sudden loss of perhaps 40,000lb of offset thrust could be nightmarish.

Still, the siren call of improved fuel consumption has led to many studies over the years, most of which are poorly detailed publicly.

Boeing B-52X

One study for a major re-engining redesign is known to this author from a single Pratt & Whitney memo, including a letter from Boeing discussing the 'B-52X'. This mid-1975 study was, at least at the time of the memo, in the preliminary concept phase and included replacement of the standard eight Pratt & Whitney TF33 turbofans with options such as six or eight JT10D-2s or four JT9D-70Ds.

The letter provides three simple top view sketches of aircraft configurations with four of the 50,000lb thrust class JT9D-70D high bypass turbofans. The

Boeing B-52X Configuration 1

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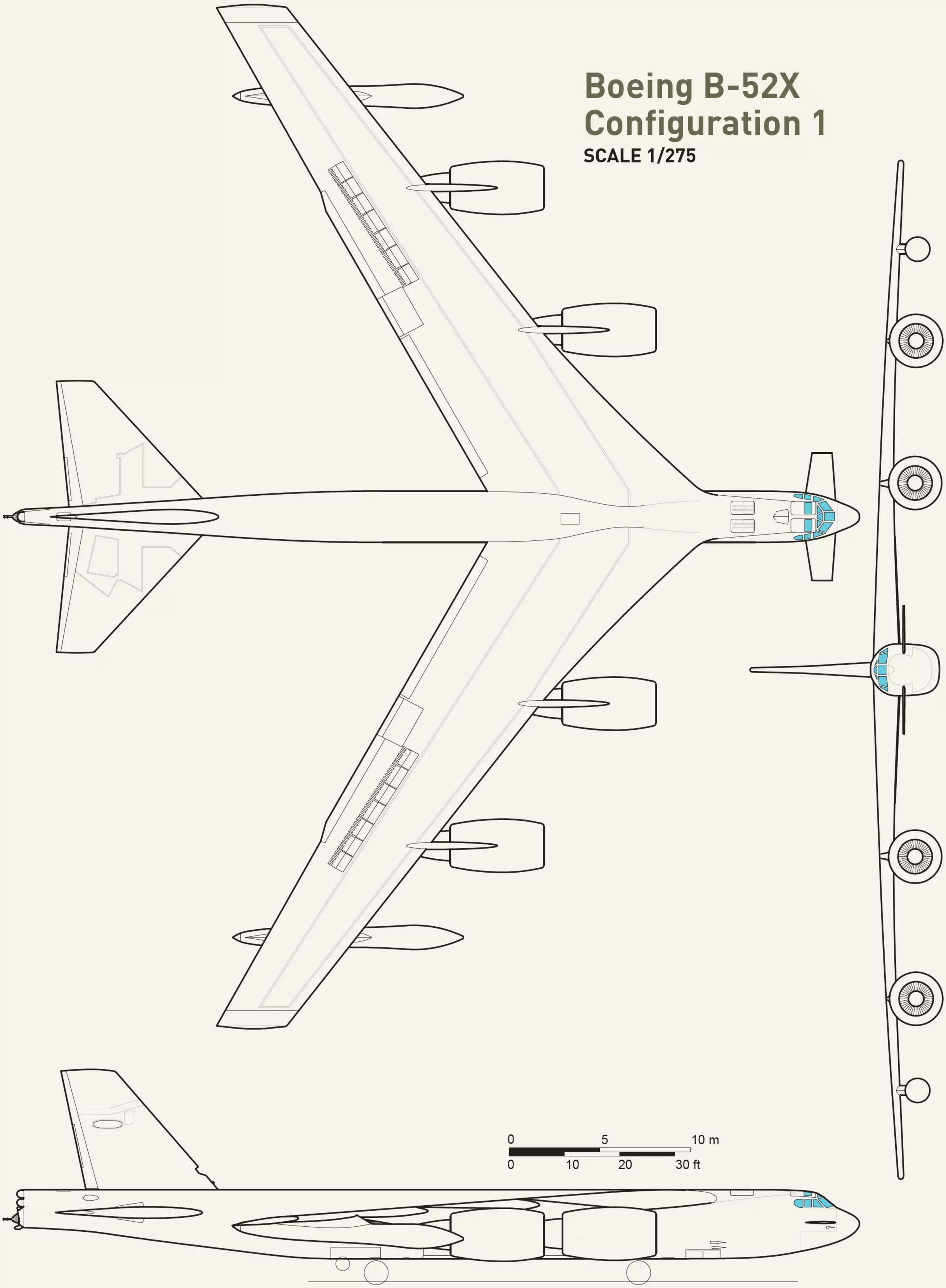

Boeing B-52X Configuration 2

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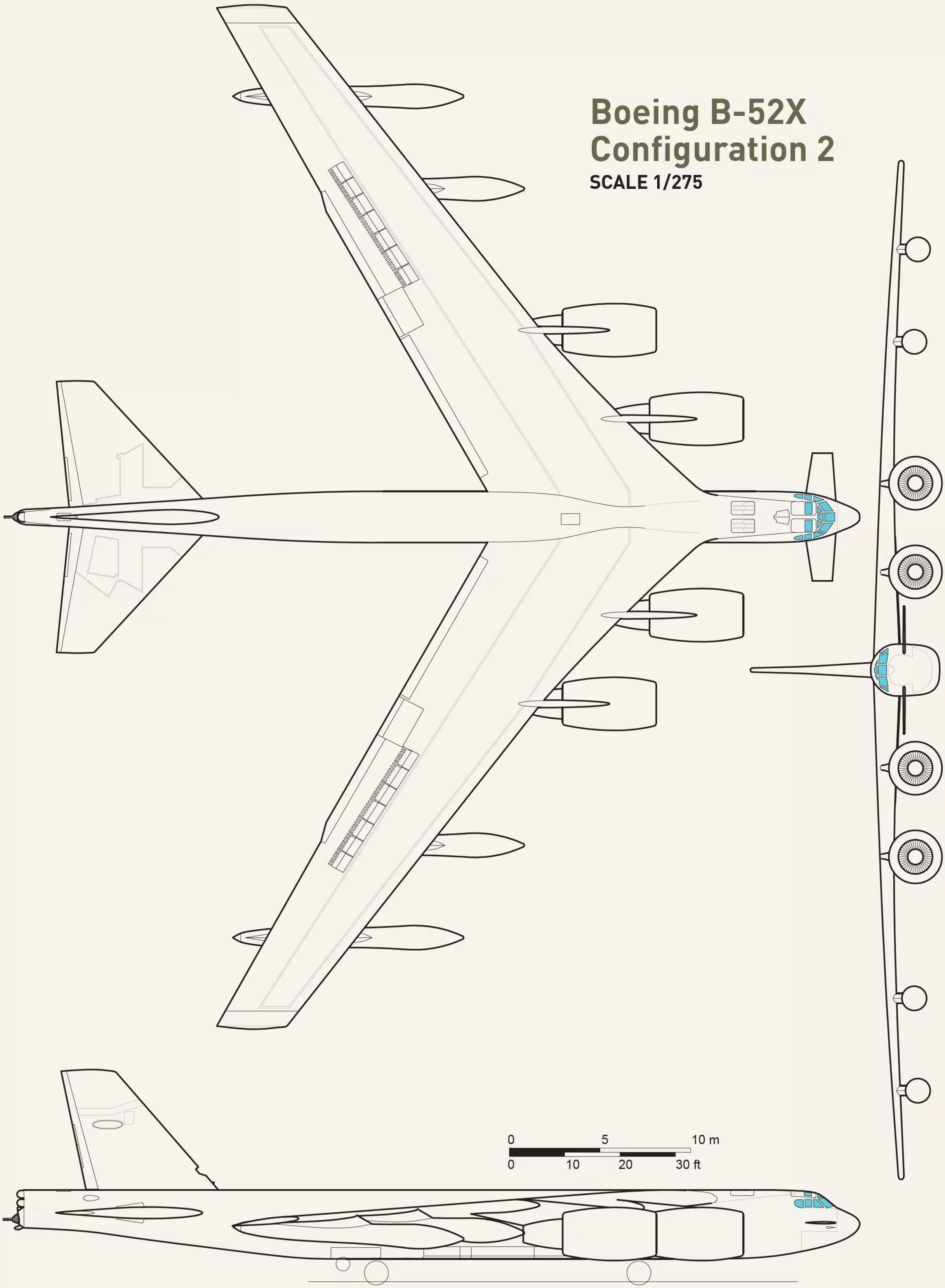

Boeing B-52X Configuration 3

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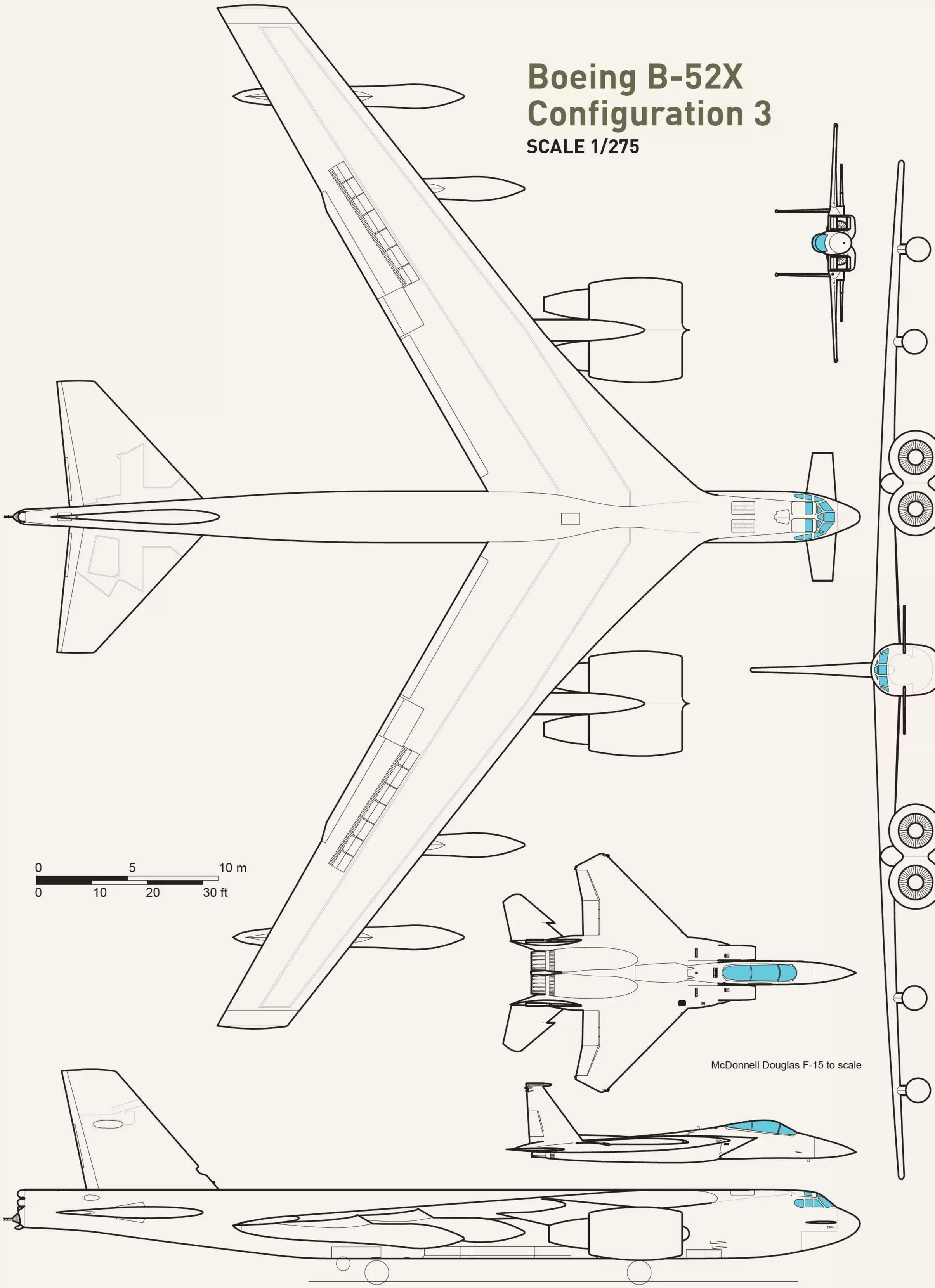

Boeing B-52G
CFM56 re-engined

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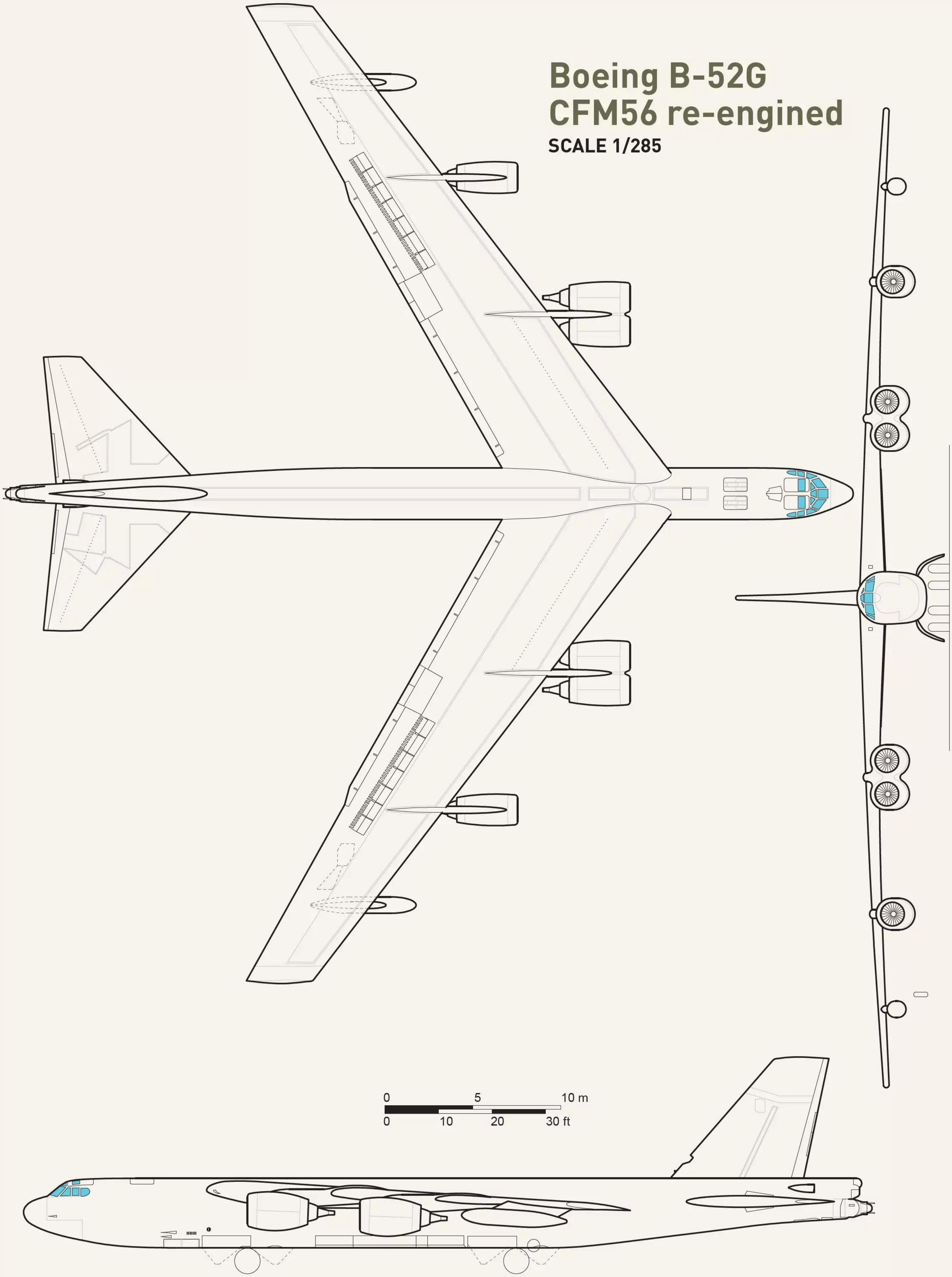

configurations differed from each other in that the first design replaced the existing B-52 engine pylons with new pylons at wing butt lines (WBL) of 410 and 720in; the second design kept the inboard pylon position and moved the existing outboard engine pylon to an extreme inboard position of WBL 218in; a third design showed a single pylon at WBL 410in that used a dual-engine pod.

Ground clearance was an issue for these designs, especially for Design 1. The outboard engine had a ground clearance of only 23in under fully loaded conditions.

Along with the change in engines, a few other changes were also made. Ride control canards, similar to those used on the B-1 bomber and demonstrated on the NB-52E Control Configured Vehicle demonstrator, were to be included. Their position was shown in planform view, but their anhedral/dihedral and vertical location are unknown and are shown in the reconstruction diagrams purely provisionally. It is unknown if a vertical fin such as the NB-52E had was also to be employed.

Curved extensions were also added to the main wing roots, continuing forward almost to the cockpit. These were similar to, though much larger than, the wing root extensions added to B-52s that carried the AGM-86B Air Launched Cruise Missile; in that case the root extensions were largely for Soviet reconnaissance satellite identification purposes, but the wing root extensions for the B-52X were almost certainly meant for aerodynamic purposes. Some performance charts were provided for the engines, but not on the aircraft themselves.

Boeing B-52 with CFM56s

Known from a single undated blueprint, one concept for re-engining the B-52 saw a B-52G equipped with six jetliner-style high-bypass turbofans. The engine layout was much like that of the XB-52 when it tested the J75 engine… twin-engine nacelles on the inboard pylons and a single engine on the outboard pylons. The twin-engine nacelle was necessarily quite a bit larger than the two-engine nacelles on the standard B-52G.

While data on this concept is lacking, the engines are a close match for the CFM56-2 turbofan (manufactured by CFM International, a company jointly owned by Safran Aircraft Engines of France and GE Aviation of the USA). If this is accurate, it would date the concept to no earlier than 1973 or so, but probably much later, as studies of re-engining the B-52 with six CFM56s are known to have been performed in the mid to late 1980s.

The CFM56-2 engine was used to re-engine early jetliners as the 707 and DC-8; re-engining the B-52 with it would have certainly made sense. This engine could generate around 22,000lb of thrust; six of them would give the B-52 132,000lb of thrust compared to the 13,750lb of thrust possible from the J57-P-43WB (totalling 110,000lb).

Boeing B-52 with PW2037s

Pratt & Whitney described a concept for replacing the eight engines of the B-52G and B-52H with four of its PW207 high bypass turbofans in 1982. These engines were designed for and used on the first generation of Boeing 757 jetliners; Pratt & Whitney's suggestion was to use the same engines and the same nacelles on the B-52.

The pylon would be similar to that of the 737 and modified in design to fit the engine closely to the wing, with the top edge of the fan exhaust just ahead of and essentially level with the leading edge of the wing. This would give a ground clearance of about 33in compared to 56in for the J57 nacelles on the B-52G. Some relatively minor modifications to the engines would be needed for the higher altitudes the B-52s were expected to operate at.

Pratt & Whitney estimated that the PW2037 engines would burn fuel at a rate 40% less than the J57s and 30% less than the TF-33s. This would result in an increase in unrefuelled range of 65% and 45% compared to the B-52G and B-52H, respectively. This would also translate into considerable increasing in loiter time for maritime support missions (likely referring to anti-submarine missions).

For a mission radius of 1,000 nautical miles, the loiter time on station would be 18 or 19 hours; certainly impressive, but likely a bit of a nuisance for the crew who would have to stay awake through all that. On the other hand, for a mission radius of 4,000 nautical miles, loiter time on station would still be three or four hours.

Four PW2037 engines would provide 35% more takeoff thrust than eight J57s, shortening the takeoff roll by 27%, able to lift off in 6,400ft on a hot day. This would not only speed the launching of B-52s, it would increase the number of available fields that the B-52 could use, allowing greater dispersion. All of these performance improvements would also come with cost savings; Pratt & Whitney estimated that each B-52G with the new engines would save some 715,000 gallons of fuel per year.

Boeing B-52 with C-17 nacelles

Seven years later, LTV studied a very similar concept: using the nacelles from Boeing's own C-17 on the B-52G. The C-17 is equipped with PW2040 engines, very similar to the PW2037 engines of the 757, with similar nacelles. The available documentation indicates a very preliminary study, merely examining the possibilities of such an engine swap; the performance of the aircraft was not presented. However, it would most likely have been quite a bit like the earlier study with the PW2037. It was found that a high g turn on the ground with fully laden wing and tip tanks would reduce clearance from the runway to the bottom of the outboard nacelle to a mere 8in. Entirely new pylons would be needed.

Boeing B-52H w/PW2037

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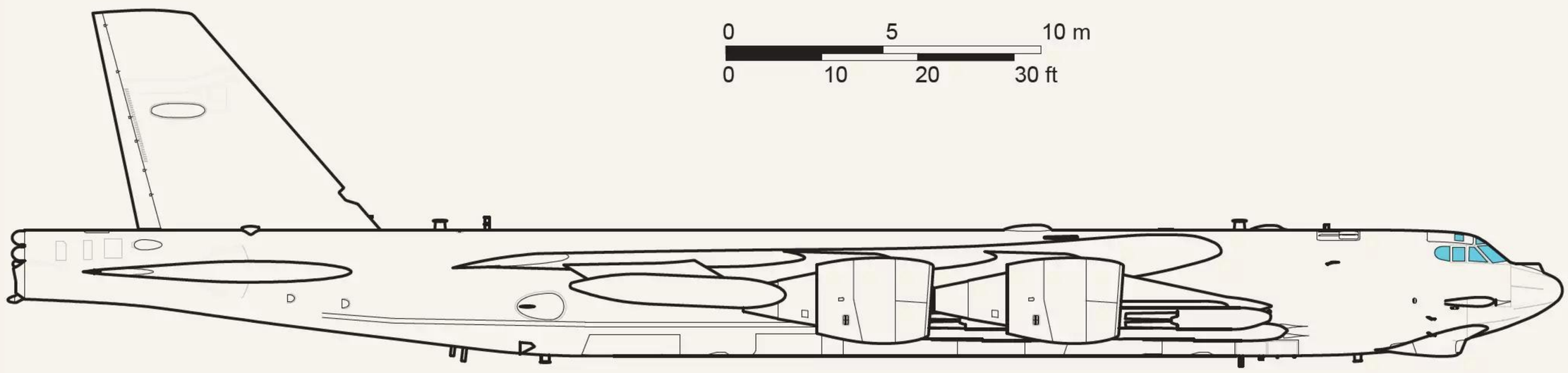
0 5 10 m

0 10 20 30 ft



Boeing B-52G w/C-17 Nacelles

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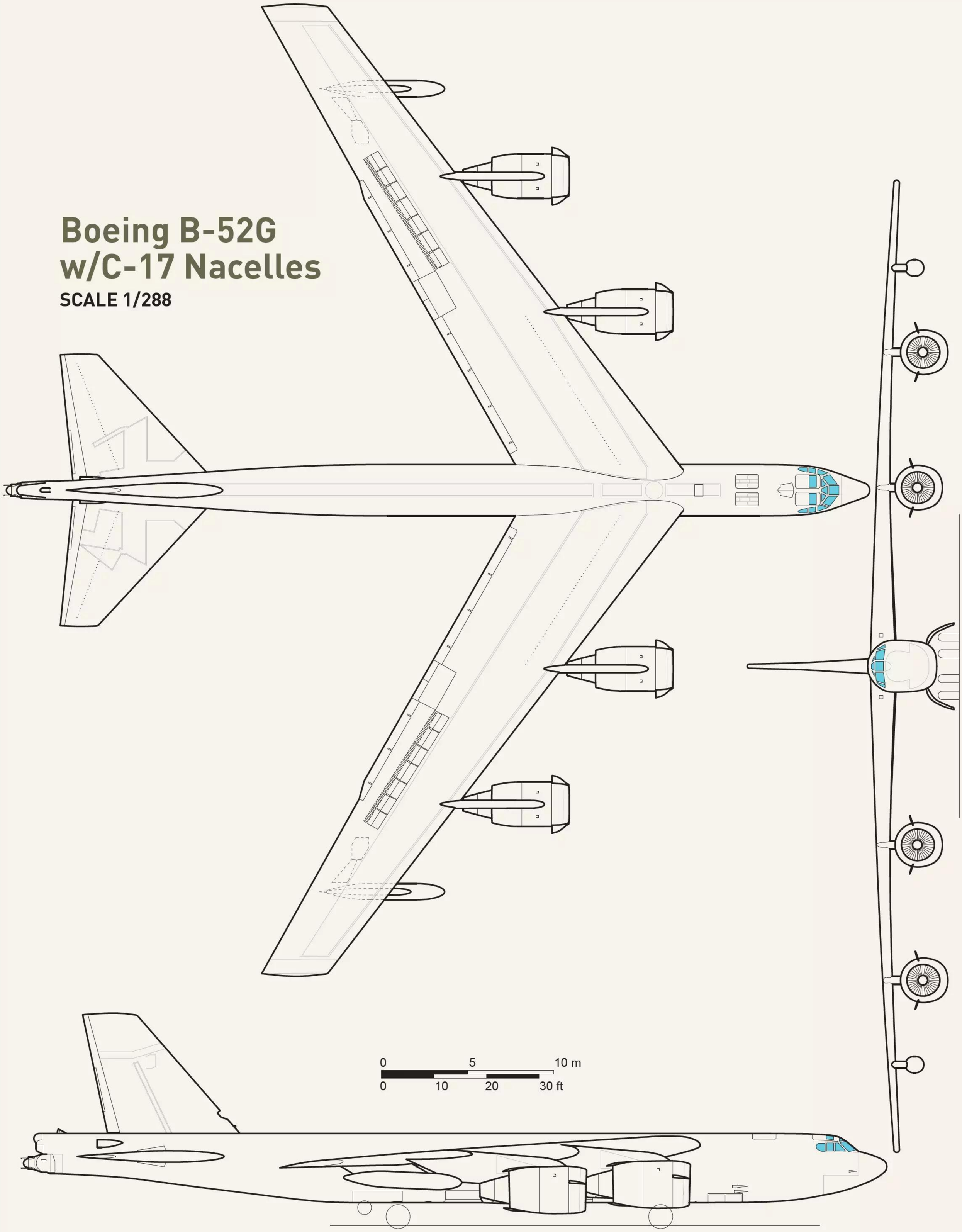

Boeing B-52H AML II

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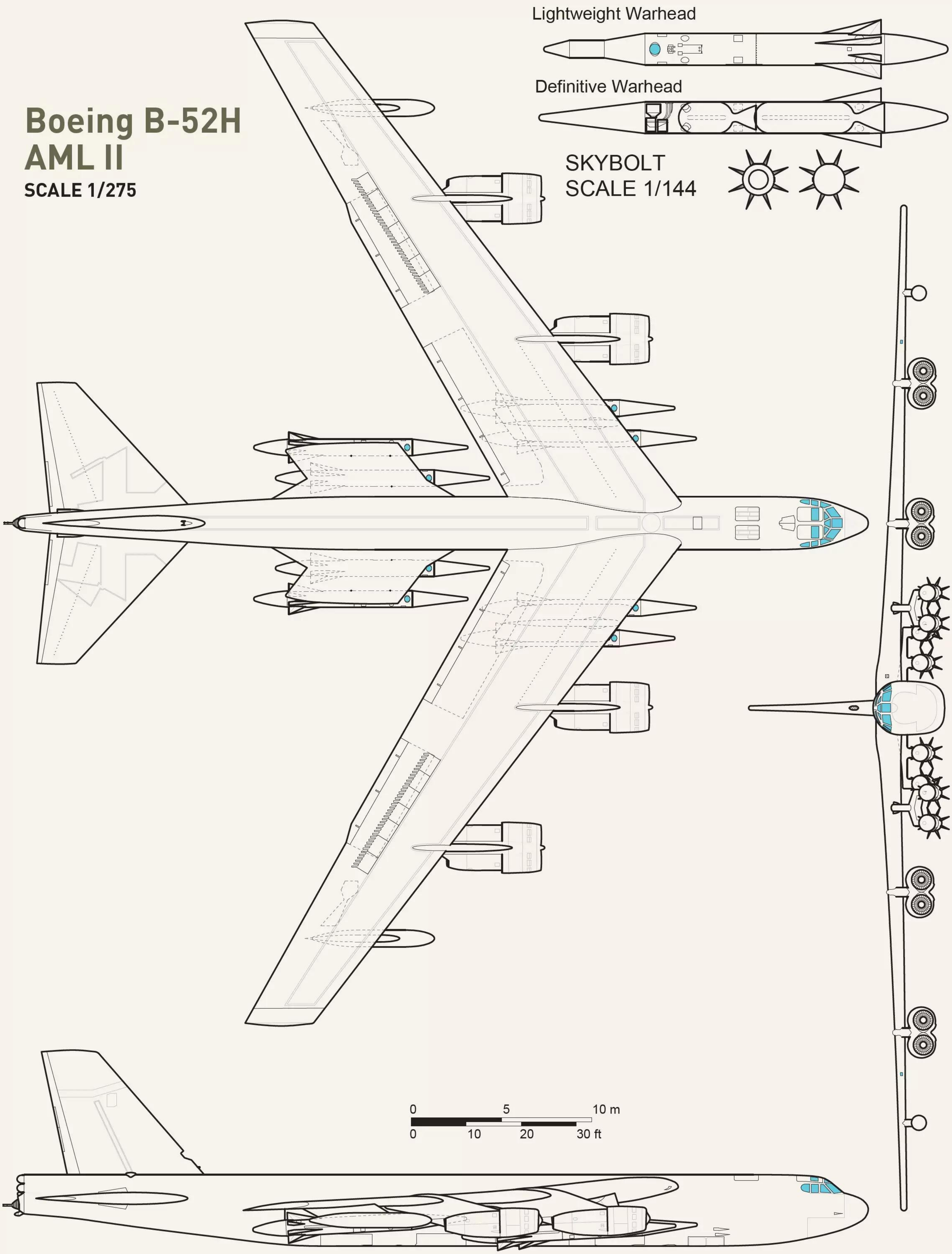

Boeing Model 877-1

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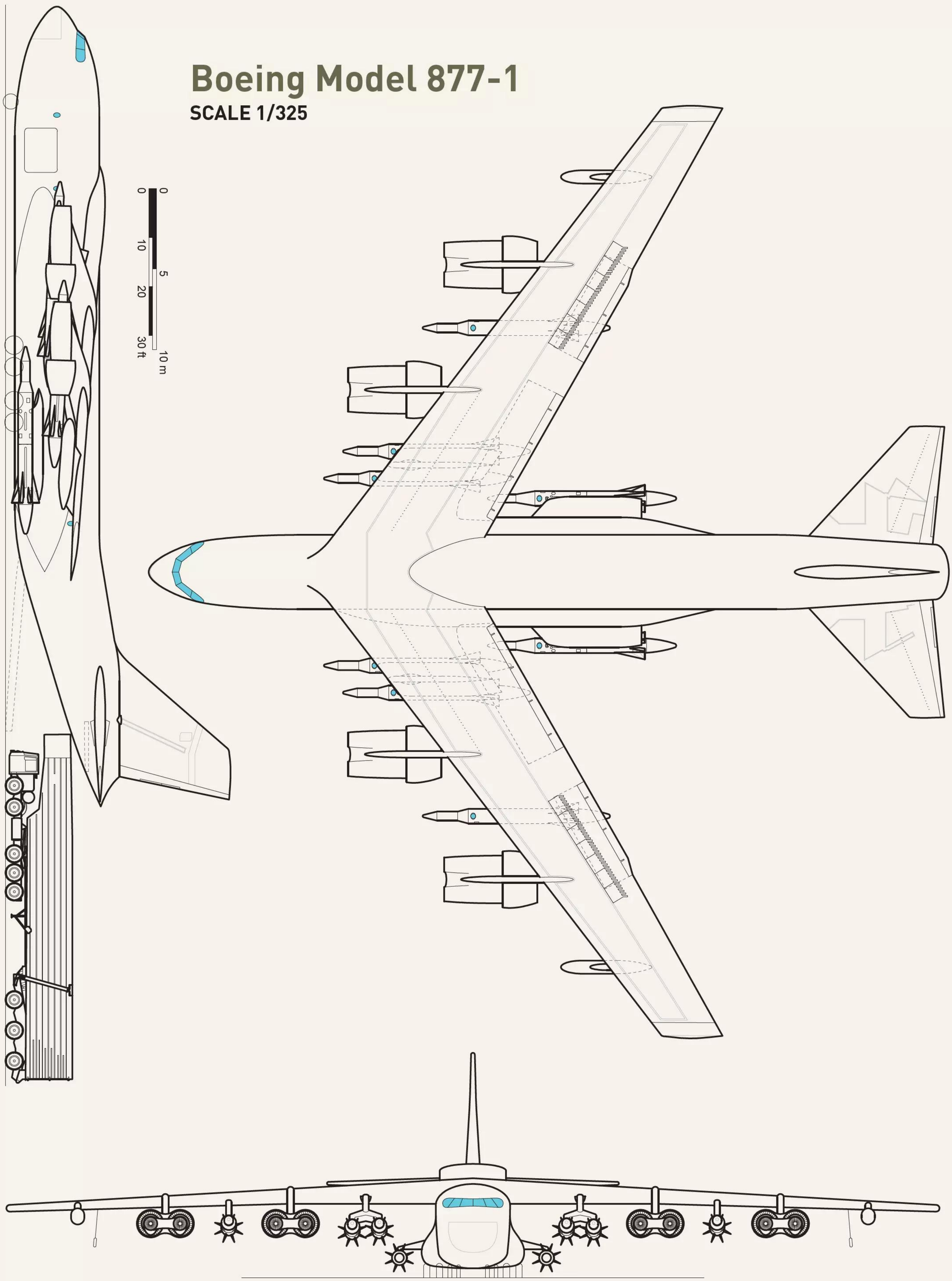

Boeing B-52H AML II

There exists a diagram of an evolved version of the B-52H/Skybolt weapons system. Along with the four missiles carried under the wing, the Airborne Missile Launcher (AML) II would have carried a further four Skybolt missiles. Rather oddly, these would not have been carried under the wings, but instead under pylons that were attached to the sides of the rear fuselage.

This would seem to have been an unfortunate position from the standpoint of centre of gravity; presumably some fuel tankage would have been deleted from the rear fuselage to offset it. This would have greatly reduced overall fuel capacity and thus the range and duration of the aircraft, making in-flight refuelling essential. Once in flight, the rear fuselage pylons would have been able to generate some measure of lift to offset their own weight and the weight of the missiles. No further information on the configuration is available at this time, however. The missiles are depicted with the final conical GE re-entry vehicle, so the design likely dates from later than March 1961.

Boeing Model 877-1

Boeing submitted several responses to an Air Force System Study Directive for a 'Multipurpose Long Endurance Aircraft' in 1960. The MPLEA was to fulfil two roles: cargo carrier and carrier/launcher of the Skybolt air-launched ballistic missile. The Seattle division turned in designs based on then-current Boeing transport aircraft studies, but the Wichita division turned in a design based in part on the B-52. Model 877-1 used the wings and tail surfaces of the B-52G married to an entirely new fuselage, somewhat in the manner of the Model 820 designs.

The Model 877-1 fuselage was quite sleek and aerodynamic when compared to the Model 820 designs, with more than a passing resemblance to the Lockheed C-141. As with the C-141, the nose of Model 877-1 did not open up to provide drive-on access to the cargo bay. The rear featured a large loading ramp; a smaller cargo door was available on the port side of the forward fuselage for loading smaller items and troops.

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B-52 evolution

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General data table

Aircraft	Source Grade	Crew	Span	Wing area (sq ft)	Length	Engines	Dry weight (lbs)	Design Fuel (lb)	Design Payload (lbs)	Max Payload (lbs)	Gross weight (lb)	Range (n.mi.)	Cruise speed	Max speed	Ceiling (ft)
Boeing Model 360	3		220 ft 0 in	5300	120 ft 0 in					40,000					
Boeing Model 361	4		200 ft 0 in	3970	130 ft 0 in					40,000					
Boeing Model 362	3	8	300 ft 0 in	9041.3	176 ft 0 in	eight undefined		223,400	10000	88,000	470000	10,000		350 mph @ 30k ft	40,000
Boeing Model 365	4	9	219 ft 0 in	4000	157 ft	four P&W X Wasp	124950	86410	10000	51,200	230000	N/A	N/A	N/A	N/A
Boeing Model 384	4	9-12	204' 3.25"	3087	144 ft 4 in	4 P&W Wasp Major R-4360-5	103039	92030	10160		210500	7430	189 mph @ 15 k ft	318 mph @ 30k ft	29,000
Boeing Model 385	3	9-15	251 ft 0 in	4500	161 ft 0 in	six P&W Wasp Major	160,020	139180	10000	64,000	315000	8210		329 mph @ 30k ft	
MCD 392	4	15	280'	7140	129' 4"	8 Allison V-3420	216,610		16,000	120,000	500,000	11,250 (16 klbs) 6,100 (120 klbs)		342 mph @ 20k ft	20,000
B-36D	4	13	230' 0"	4772	162' 1"	6 P&W R-4360-41 radials 4 GE J47-GE-19 turbojets	160,974	170,148	10,000	86,000	357,500	6278	182 knt @ 10-25 kft	373 kts @ 34,500 ft	36,800
Consolidated 10-engine high performance patrol	3	5	148' 4"	2200	129' 9"	6 Westinghouse 25D turboprops 4 Westinghouse X24C-4A turbojets	93,481	68,000		24,000	167,000	1650 radius	325 mph	485 mph @ 25 kft	30,000
Consolidated heavy Bombardment	3	9	141' 8"	2000	145' 4"	4 Wright TGAA turboprops	90,430	55,000	22,275	41,274	175,000	5670	375 mph	477 mph @35 kft	41,000
Consolidated long range heavy bombardment	4	11	167'	4000	172' 6"	4 T-35 turboprops 4 TG-180 turbojets	116,443	98,200	10,000		235,000	2445 radius	364 mph	520 mph @ 35 kft	44,300
B-29 turboprop	2		141' 3"	1736	99' 0"	4 unspecified turboprops									
Boeing Model 461	3	5	164' 3.6"	1800	131' 6"	4 Wright T-35-1			39,400						
Boeing Model 462	4		221' 0"	3250	161' 2"	6 Wright T-35-1	87,960		82,040		360,000	3100 radius		382 knots	
Boeing Model 462-5	4		221' 0"		165' 4"	6 Wright T-35-1									
Boeing Model 464-17	4	11	205' 0"	3000	156' 0"	4 WAC 827 GTAI (T-35-5)	176,000			90,000	480,000				
Boeing Model 464-18	4	11	145'	1500	~128' 4"	2 Wright T-35-3	83,300		10,000		180,000	10,900		460 knots	
Boeing Model 464-25	4	9	205' 0"	3300	147' 8"	4 XT35-W-3	149,340			12,000	400,000	12,665			
Boeing Model 464-27	4	9	205' 0"	3600	148' 8"	4 XT35-W-3	149,880			12,000	400,000				
Boeing Model 464-33	4	8	185' 0"	2600	124' 10"	4 XT35-W-3	149,880			12,000	260,000				
Boeing Model 464-34-3	4		185' 0"	2600	136' 4"	4 XT35-W-3					285,000				
Boeing Model 464-35	3	5	185'	2600	131.3'	4 Wright XT-35-W-5	132,410	127,500	15,000		280,000		435 knots	435 knots at 35,000 ft	42,100
Boeing Model 464-40-4	3		185'	2600	143' 4"	8 Westinghouse J40			15,000			6750		536 mph @ 35kft	45,200
Boeing Model 464-41	3	5	185' 0"	2600	130' 9"	4 XT35-W-3	133,560	21,400 gal	15,000		280,000				
Boeing Model 464-46	3		185' 0"	2600	130' 9"	6 Westinghouse XJ40-10	118,310				284,000				
Boeing Model 464-47	3		185' 0"	2600	130' 9"	6 P&W XJ-57	125,000				281,000				
"Hotel proposal"	3		185' 0"		138' 9"										
Boeing Model 464-49	3	5	185' 0"	4000	137' 11"	8 P&W XJ-57	152,300	165,600	10,000	25,000	330,000	2660	453 knots	490 kts @ 49,400 ft	49,400
B-36J turboprop (B-60)	3		206' 4.79"	5239.11	168' 7.8"	4 Wright T35 turboprops									
YB-60		5	206.4'	5239	171.2'	8 P&W YJ57-P-3	136,292	42,106 gal	10,000	72,000	410,000	2910 radius	400 kts @ 37-53 kft	448 kts @35,332 ft	47,400
Douglas 1211-J	4	9	227' 6"		160' 6"	4 turboprops		170,400			322,000	11,000		>450 knots	50,000
Douglas Model 1064	3		97'	4700	83' 6"	4 turbojets									

Aircraft	Source Grade	Crew	Span	Wing area (sq ft)	Length	Engines	Dry weight (lbs)	Design Fuel (lb)	Design Payload (lbs)	Max Payload (lbs)	Gross weight (lb)	Range (n.mi.)	Cruise speed	Max speed	Ceiling (ft)
Fairchild M-121	4	4	116' 6"	1900 3800 total	78' 10"	10 Westinghouse J46-WE-2	52,256	91,019 (AC) 85,550 (wing)	10,000		154,600 (AC) 251,600 (biplane)	5130 radius	487 knots	600 kts sea level	
RAND G-2	3	6	141'	4000	86.5'	4 turboprops		25,000 gal	10,000		300,000	8000	525 mph		
Northrop B-49	3	6	172.0'	4000	53.1'	8 Allison J35-A-15	88,442	14,542 gal		16,000	193,938	1483 radius	365 knots	428 kts @20,800 ft	45,200
Boeing Model 481-100	3	6	185' 0"	4500	73' 3"	8 Westinghouse XJ-40-WE6	118,780				320,000				
Boeing Model 474	3	8	135'	1500	118' 11"	4 Allison T-40-A2 turboprops	78,000		10,000		153,000	1878 radius	416 knots	440 knots	40,000
Boeing Model 479	3	7	150' 0"	2500	132' 1"	8 Westinghouse XJ-40-WE6	101,760		10,505		235,000	1737 radius	435 knots	550 knots	44,000
Boeing Model 483-11	3		130' 0"		114' 6"										
Boeing Model 483 delta	3		~111'		~76'										
Boeing Model 484-106	3		92.3'	2990	74.0'	10 Westinghouse XJ-40-WE-10	63,610	12,200 gal	10,250		150,000				
Boeing Model 484-230	3	4	110' 7"	8500	88.7"	6 turbojets		14,950 gal			175,000				
XB-52 Model 464-67	3	5	185' 0"	4000	152' 8"	8 P&W J-57-P-8	160,000	38,865 gal			405,000	3070 radius		483 kts @ 40 kft	39,000
B-52A	4	5	185' 0"	4000	156' 6.9"	8 P&W J57-P-1W	167,509	37,550 gal		34,000	420,000	3110 radius			
B-52 B	4	5	185' 0"	4000	~160' 1"	8 J57-P-1W/WA/ WB/29W/29WA/18W	177,832	37,550 gal		63,000	420,000	3110 radius	453 kts @ 35-51 kft	546 kts @ 19,600 ft	47,300
B-52C/D	4	5	185' 0"	4000	156' 6"	8 J57-P-29WA/19W	170,126	41,500 gal		64,000	450,000	3305 radius	453 kts @ 33-51 kft	551 kts @ 20,200 ft	46,950
B-52E	4	5	185' 0"	4000	156' 6"	8 J57-P-29W/29WA/19W	172,720	41,500 gal		65,000	450,000	3320 radius	453 kts @ 33-51 kft	551 kts @ 20,200 ft	46,950
B-52F	4	5	185' 0"	4000	156' 6"	8 J57-P-43W/WA/WB	179,158	41,500 gal		65,000	450,000	3625 radius	453 kts @ 33-51 kft	553 kts @ 20,500 ft	47,600
B-52G	4	5	185' 0"	4000	157.6'	8 J57-P-43WB	158,737	47,975 gal		104,900	488,000	3915 radius	454 kts @ 33-52 kft	553 kts @ 20,500 ft	48,150
B-52H	4	5	185' 0"	4000	159' 4"	8 TF33-P-3	165,988	48,030 gal		105,200	488,000	4510 radius	456 kts @ 33-52 kft	555 kts @ 20,700 ft	47,800
Boeing Model 464-72	3		185' 0"	4000	152' 8"	4 P&W JT-3A turboprops	170,950				390,000				
Boeing Model 464-74	3		185' 0"	4000	152' 8"	4 P&W JT-3A turboprops	159,500				390,000				
Boeing Model 464-79-0	3	5	245' 0"	4560	152' 8"	8 P&W J57					445,000				
Boeing Model 464-149	3		230' 0"	4460	152' 8"	8 P&W J57P									
Boeing Model 464-EXT #1	3		230' 0"	4460	152' 8"	8 P&W J57									
Boeing Model 464-EXT #2	3		230' 0"	4460	152' 8"	8 P&W J57									
Boeing Model 724-15 (core)	4	4	93' 6"	2500	156' 8"	4 GE R56 AGT120	135,500		20,000		370,000			1725 knots	63,000
Boeing Model 724-15 full air vehicle	4	4	275' 2"	7500		4 GE R56 AGT120		365,700			580,000	3030 radius	489 knots		
Boeing Model 464-197	4	3	122' 6"	5000	174' 4"	8 afterburning J67-W-1	172,140	38,868 gal	10,000	50,000	425,000				
Boeing Model 464-238	3		218' 0"	5600	156' 6.9"	8 P&W J67									

Aircraft	Source Grade	Crew	Span	Wing area (sq ft)	Length	Engines	Dry weight (lbs)	Design Fuel (lb)	Design Payload (lbs)	Max Payload (lbs)	Gross weight (lb)	Range (n.mi.)	Cruise speed	Max speed	Ceiling (ft)
Boeing Model 464-239	3		185' 0"		156' 6.9"	8 P&W J67									
Boeing Model 464-245	3	5	185' 0"		156' 6.9"	4 J75		83,000 LH2 134,000 JP							
Boeing Model 464-246	3	5	197' 6"		180' 5"	6 J75		89,850 LH2 152,000 JP							
Boeing Model 491	3	6	205'	3000	109'	6 Allison T-40 turboprops		39,000 gal			375,000				
Fairchild XB-52 NEPA 1	3		185'	4000	~155' 9"	6 nuclear XJ-57					350,000		Mach 0.8 @ 35 kft		
Fairchild XB-52 NEPA 1	3		185'	4000	~151' 4"	6 nuclear XJ-53					340,000		Mach 0.8 @ 40 kft		
Fairchild NEPA N-14	3	7	185' 0"	4000	164' 8"	6 XJ-53 turbojets					340,000			480 kts @ 30 kft (nuc) 550 kts @ 21 kft (n+c)	41,500 (n) 46 kft (n+c)
Fairchild NEPA N-15	3	7	185' 0"	4000	149' 4"	4 XJ-53 turbojets					326,000			462 kts @ 27 kft (nuc) 520 kts @ 25 kft (n+c)	30,200 (n) 38 kft (n+c)
Fairchild NEPA N-16	3	7	185' 0"	4000	151'	6 XJ-53 turbojets					305,000			495 kts @ 30 kft (nuc) 555 kts @ 21 kft (n+c)	43 kft (n) 48 kft (n+c)
GE LF-2	2		185' 0"	4000	~153.5'	8 nuclear J73							Mach 0.75 @ 35 kft		
B-52 flying test bed	3		185' 0"	4000	~159.8'	8 J57-P-43WB 1 XNJ140E-1		157,000			450,000		Mach 0.6 @ 30 kft	Mach 0.84@ 44kft	
Boeing Model 702-138(1)-1 MX-2145	3		211'	5220	171'	8 Liquid Metal Cycle Turbojets			20,000		232,000			Mach 0.75	60,000
Boeing Model 703	4	5	140' 0"	2516	122' 1"	4 afterburning J40-WE-8	82,080		30,000		175,000				
Boeing Model 713-1-133	3	4	232.5'	9000	190.2'	14 P&W J75	260,400	329,600	10,000		600,000				
Boeing Model 713-1-133C	3	4	232.5'	9000	190.2'	16 GE X-84	252,650	337,350	10,000		600,000				
Boeing Model 713-1-138	3	4	245'	10,000	190.2'	16 GE X-84					600,000			517 knots	
Boeing Model 809-1004	3		80' "	1270	152' 3"	34 J85 turbojets		320,000	10,000		463,000				
Standby Alert	3		200'	4475	156' 6.9"	4 P&W t57 turboprops	167,400				500,000				
B-52X 1	2		185' 0"	4000	157.6'	4 JT9D-70D turbofans									
B-52X 2	2		185' 0"	4000	157.6'	4 JT9D-70D turbofans									
B-52X 3	2		185' 0"	4000	157.6'	4 JT9D-70D turbofans									
CFM56 Re-engined B-52	4		185' 0"	4000	157.6'	6 CFM56 turbofans									
C-17 nacelles for B-52	3		185' 0"	4000	157.6'	4 PW2040 turbofans									
PW2037 re-engined B-52	4		185' 0"	4000		4 PW2037 turbofans									
Flashback	3	0	95.8' (dia)		297.3'										
XB-52/J75	2		185' 0"	4000	152' 8"	4 P&W J-57-P-8 2 J75									
JB-52E	2		185' 0"	4000	156' 6"	6 J57-P-29W 1 TF-39 or 1 JT-90 or 1 CF6									
NB-52E	2		185' 0"	4000	~173.3'	8 J57-P-29W		360,000							
NB-52															
Model 877-1	3		190' 4"	4162.3	162' 7"	8 GE MF 288 Aft Fans									

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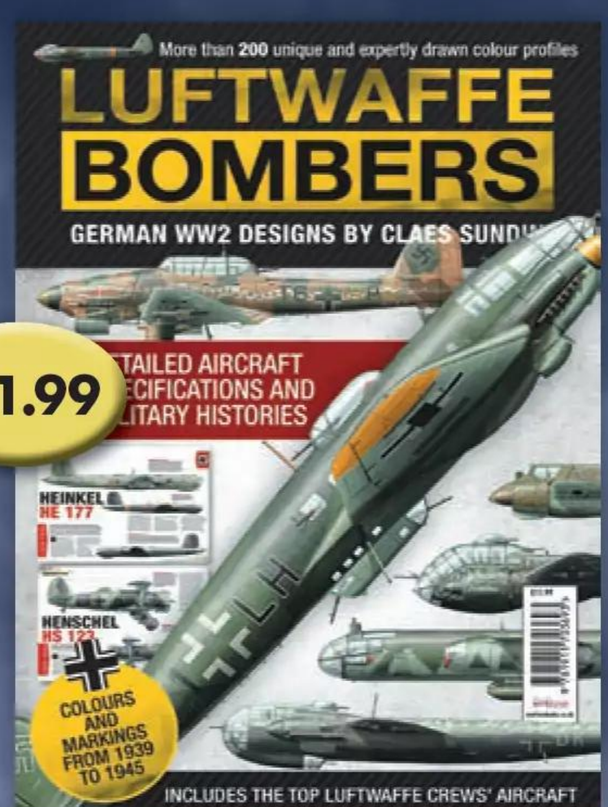

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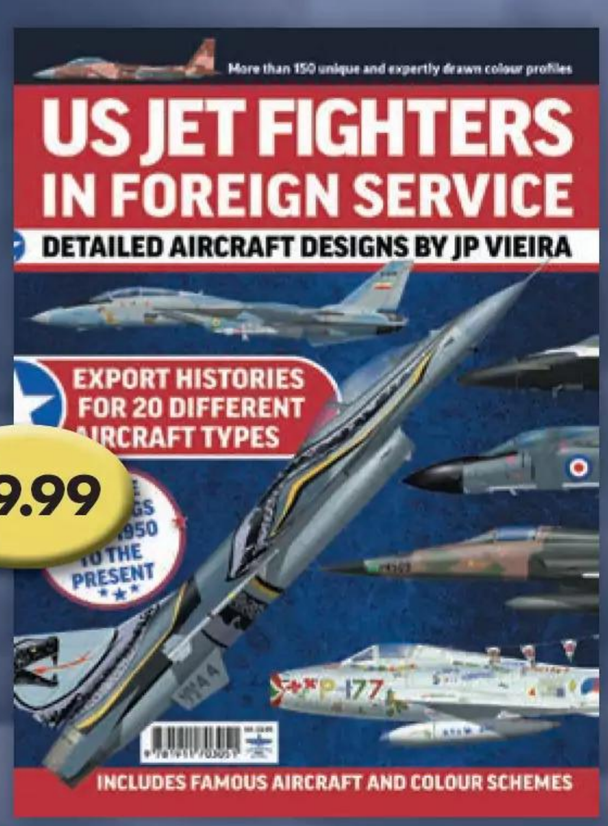

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